Russian Journal of Herpetology Vol. 21, No. 2, 2014, pp. 89 – 148

TAXONOMY AND DISTRIBUTION OF NARROW-MOUTH FROGS OF THE GENUS *Microhyla* TSCHUDI, 1838 (ANURA: MICROHYLIDAE) FROM VIETNAM WITH DESCRIPTIONS OF FIVE NEW SPECIES

Nikolay A. Poyarkov, Jr.,[1,2] Anna B. Vassilieva,[1,2] Nikolai L. Orlov,[3] Eduard A. Galoyan,[2,4] Tran Thi Anh Dao,[5,6] Duong Thi Thuy Le,[5] Valentina D. Kretova,[1] and Peter Geissler[6]

Submitted May 6, 2014.

We review the taxonomy and distribution of *Microhyla* Tschudi, 1838 (Anura: Microhylidae) species from Vietnam, with a special regional focus on the southern parts of the Annamite mountain range (Kon Tum and Langbian Plateaus, Tay Nguyen highlands) and its foothills. Recent field work in this area revealed specimens of five yet undescribed species, which are differentiated from all congeners by a combination of morphological traits: *Microhyla pineticola* sp. nov. from Lam Dong and Dak Lak provinces; *Microhyla pulchella* sp. nov. from Lam Dong Province; *Microhyla minuta* sp. nov. from Dong Nai Province; *Microhyla darevskii* sp. nov. from Kon Tum Province; and *Microhyla arboricola* sp. nov. from Dak Lak and Khanh Hoa provinces. *Microhyla annamensis* Smith, 1923 is redescribed based on recently collected material. The intrageneric systematic relationships of the new species are discussed. We provide first larval descriptions for four of the new species as well as for *Microhyla annamensis* Smith 1923. Notes on the breeding ecology and natural history of all above mentioned species are compiled for the first time. With *Microhyla minuta* sp. nov. and *Microhyla arboricola* sp. nov. we describe the probably smallest tetrapods currently known from mainland Southeast Asia. The latter species also represents the second record of a phytotelm breeder within the genus *Microhyla*. A key to the currently known Vietnamese species of *Microhyla* is provided.

Keywords: Indochina; systematics; *Microhyla pineticola* sp. nov.; *Microhyla pulchella* sp. nov.; *Microhyla minuta* sp. nov.; *Microhyla darevskii* sp. nov.; *Microhyla arboricola* sp. nov.; *Microhyla annamensis*; miniaturization; tadpole; phytotelm breeding

INTRODUCTION

Pigmy narrow-mouth frogs or rice frogs of the genus *Microhyla* Tschudi, 1838 are small ground-dwelling frogs, which are a key element of the Oriental batrachofauna. They inhabit various altitudes and habitats from primary tropical forests to paddy fields in South, Southeast and East Asia. The wide range of distributions covers Asia from the Ryukyu Archipelago of Japan in the north, through Taiwan to southern mainland China, from Indochina to India and Sri Lanka to the southwest, and through Southeast Asia to the Philippines, Borneo, Sumatra, Java and Bali to the southeast (Frost, 2014). In concordance with such a wide distribution, the genus is relatively speciose with 34 species currently recognized (Frost, 2014; AmphibiaWeb, 2014), whereat 8 species were described during only the last 10 years (Bain and Nguyen, 2004; Das et al., 2007; Das and Haas, 2010; Matsui, 2011; Matsui et al., 2013; Hasan et al., 2014).

[1] Department of Vertebrate Zoology, Biological Faculty, M. V. Lomonosov Moscow State University, Leninskiye Gory, GSP-1, Moscow 119991, Russia.

[2] Joint Russian-Vietnamese Tropical Research and Technological Center under the A. N. Severtsov Institute of Ecology and Evolution (Russian Academy of Sciences), South Branch, 3, Street 3/2, 10 District, Ho Chi Minh City, Vietnam.

[3] Zoological Institute, Russian Academy of Sciences, Universitetskaya nab., 1, St. Petersburg 199034, Russia.

[4] Zoological Museum of the Lomonosov Moscow State University, B. Nikitskaya str. 6, Moscow 125009, Russia.

[5] Vietnam National University, Ho Chi Minh City, University of Science, Faculty of Biology, Department of Ecology & Evolutionary Biology, 227 Nguyen Van Cu, District 5, Ho Chi Minh City, Vietnam.

[6] Zoologisches Forschungsmuseum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, Germany.

Within Southeast Asia, Vietnam is renowned for its high diversity of amphibian species (Orlov and Ananjeva, 2007; Bain and Hurley, 2011 and references therein). The southern part of the Annamite, or Truong Son Mountains (the Da Lat, or Langbian Plateau), is one of the most poorly investigated parts of the Annamites with many species of amphibians and reptiles having been described from this area during the last several years (Nazarov et al., 2008, 2012; Rowley et al. 2010, 2011a, 2011b; Ngo and Chan, 2010; Stuart et al. 2011; Orlov et al. 2012; Vassilieva et al., 2014). Surprisingly, new herpetofaunal discoveries (Ngo and Bauer, 2008; Geissler et al., 2009; Orlov et al., 2009; Rowley et al., 2012b; Hartmann et al., 2013; Ngo, 2013; Vassilieva et al., 2013b) are being made not only in barely accessible mountain areas, but also in the foothills and lowland areas of southern Vietnam, which are covered with monsoon tropical forests and have been subject to severe anthropogenic habitat transformation and destruction during last 40 years; Vietnam has the second highest rate of deforestation of primary forests in the world (Meijer, 1973; De Koninck, 1999; Laurance, 2007; Meyfroidt and Lambin, 2008).

However, despite the remarkable herpetofaunal diversity found in Vietnam, the species of *Microhyla* described in this country are comparatively low in number, with only eleven nominal species (*M. annamensis* Smith, 1923, *M. berdmorei* (Blyth, 1856), *M. butleri* Boulenger, 1900, *M. fissipes* Boulenger, 1884, *M. fusca* Andersson, 1942, *M. heymonsi* Vogt, 1911, *M. picta* Schenkel, 1901, *M. pulchra* (Hallowell, 1861), *M. nanapollexa* Bain et Nguyen, 2004, *M. marmorata* Bain et Nguyen, 2004, *M. pulverata* Bain et Nguyen, 2004; excluding *M. erythropoda* Tarkhnishvili, 1994; see Nguyen et al., 2005, 2009; Frost, 2014; see Figs. 1 and 2 for distribution map and photos of common species). Among these taxa, *M. fusca* remains the most enigmatic, since it is known only from a single specimen from the environs of Dalat, Lam Dong Province. *M. marmorata* and *M. pulverata* from central Vietnam and adjacent Laos were for long time confused with *M. annamensis* described by Smith (1923) from Sui Kat, Langbian Plateau, southern Annam. In their major revision of Vietnamese *Microhyla* (the first such work after Bourret, 1942), Bain and Nguyen (2004) redescribed the holotype of *Microhyla annamensis* Smith, 1923, reviewed taxa confused with this species and described two new seemingly closely related forms: *M. marmorata* from central Vietnam and Laos, and *M. pulverata* from a series collected by I. S. Darevsky and N. L. Orlov in Buon Luoi, central Vietnam. However, due to a lack of original material from the Langbian Plateau, the authors could not examine contemporary series of *M. annamensis* to judge the current status and distribution of this species in Vietnam. In the same paper, Bain and Nguyen (2004) report on a diminutive species of *Microhyla*, superficially resembling the Sundanese species *M. palmipes* Boulenger, 1897. They review records of "*M. palmipes*" in Vietnam, remove this species from the list of Vietnamese herpetofauna and describe a new species *M. nanapollexa* based on a single specimen from Ngoc Linh Mt. in central Vietnam.

Recent field surveys on the Langbian Plateau and surrounding areas of southern Vietnam (2009 – 2014; Lam Dong, Dak Lak and Khanh Hoa provinces) resulted in the collection of *Microhyla* specimens belonging to three distinct morphospecies. They were tentatively classified as *Microhyla* sp. 1, *Microhyla* sp. 2, and *Microhyla* sp. 3 in a review of amphibians and reptiles of Bidoup – Nui Ba National Park (Poyarkov and Vassilieva, 2011). Further thorough examination of collected specimens showed that one of these species, *Microhyla* sp. 2, demonstrates great resemblance to the type specimens of *M. annamensis*, described by Smith (1923) and Bain and Nguyen (2004), whereas two others were shown to represent yet undescribed species. Two miniature taxa of *Microhyla*, species superficially resembling *M. palmipes*, were also found during recent surveys in lowland monsoon forests in Dong Nai Province (2006, 2011) and mountain areas of Dak Lak and Khanh Hoa provinces (2012 – 2013) in southern Vietnam. Finally, a series of large-sized *Microhyla*, superficially resembling *M. berdmorei*, was collected on Ngoc Linh Mt. in central Vietnam. Morphological analysis suggested that it also represents a yet undescribed species. All five new species are described herein. For four of them we give detailed descriptions of adults and tadpoles. We provide the first description of *M. annamensis* larvae and report on the current distribution of this species in Vietnam.

MATERIAL AND METHODS

Sample collection. Fieldwork was conducted in 1998 and between 2009 and 2013 in southern and central Vietnam (Dong Nai, Binh Phuoc, Lam Dong, Khanh Hoa, Dak Lak, Kon Tum, Quang Nam, Ba Ria – Vung Tau, Tay Ninh and Kien Giang provinces) in a number of national parks and reserves. In the field, we collected adult frogs by opportunistic search usually at night; the collected specimens were photographed in life. Tissue samples for genetic analyses were taken prior to preservation and stored in 96% ethanol. All other specimens were fixed and were stored in 75% ethanol except for ZISP 7370 – 7372, ZFMK 96230; IEBR A.2013.113 and ZMMU A-5050, which were fixed in 10% formalin and then transferred to 75% ethanol for storage. Tadpoles were fixed and preserved in 5% formalin. Collected spec-

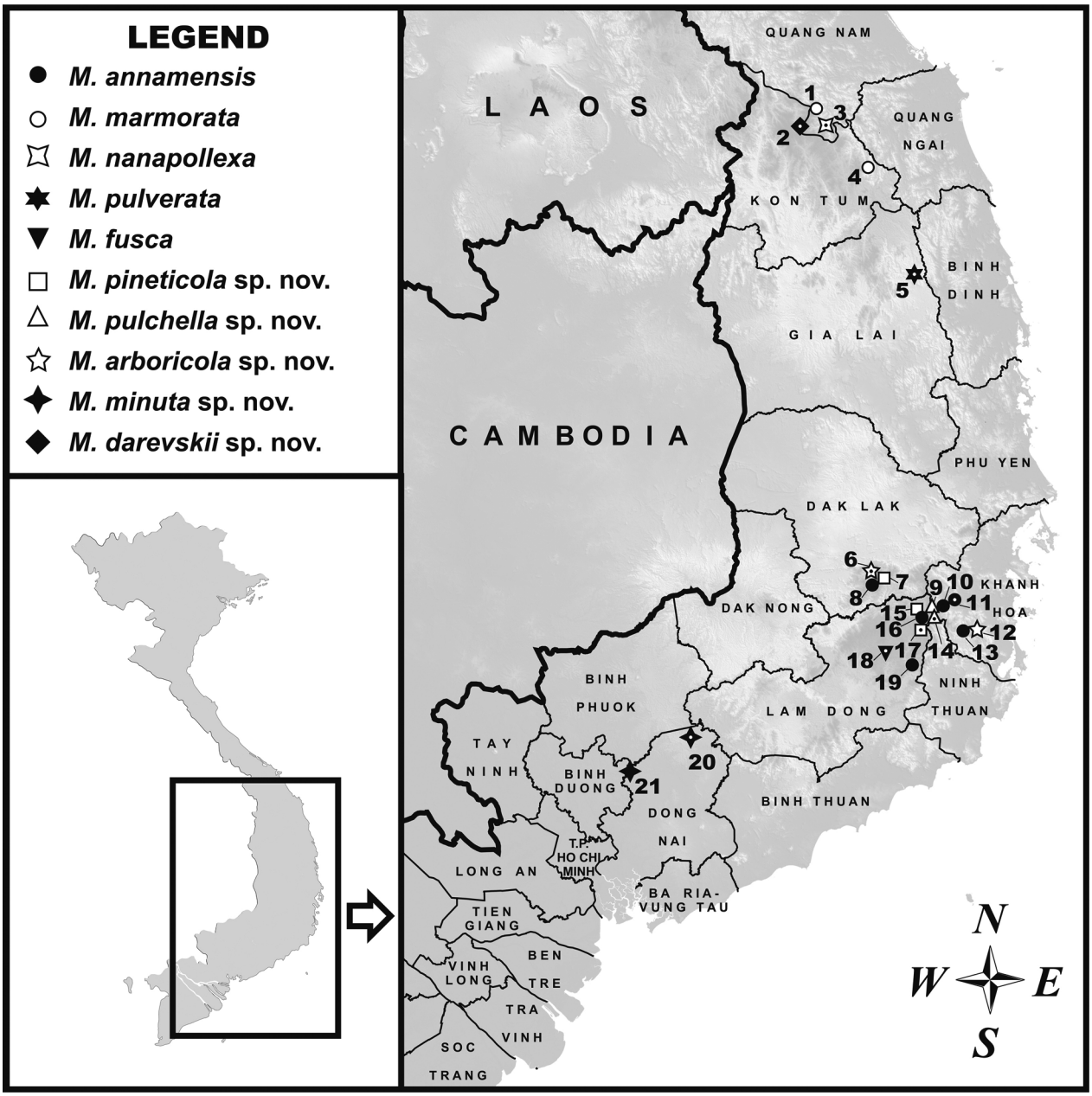

Fig. 1. Distribution of *Microhyla* species in the Annamite Mountains and adjacent regions, southern Vietnam (except widely distributed lowland species). Icon information is given in the legend; a round dot in the center of an icon denotes the type locality of a species. Locality information: *M. marmorata*: 1, Ngoc Linh Mt., Tra My District, Quang Nam Province (Bain and Nguyen, 2004); 4, Kon Plong, Kon Tum Province (Nguyen et al., 2009); *M. darevskii* sp. nov.: 2, Mang Xang Village, Ngoc Linh Mt., Dac Glei District, Kon Tum Province; *M. nanapollexa*: 3, Ngoc Linh Mt., Tra District, Quang Nam Province (Bain and Nguyen, 2004); *M. pulverata*: 5, Buon Luoi, An Khe District, Gia Lai Province (Bain and Nguyen, 2004); *M. arboricola* sp. nov.: 6, Chu Pan Phan Mt., Chu Yang Sin N. P., Krong Bong District, Dak Lak Province; 12, Hon Ba Mt., Cam Lam District, Khanh Hoa Province; *M. pineticola* sp. nov.: 7, Chu Yang Sin N. P., Lak District, Dak Lak Province; 15, Giang Ly station, Bidoup – Nui Ba N. P., Lac Duong District, Lam Dong Province; 17, Bi Doup Mt., Bidoup – Nui Ba N. P., Lac Duong District, Lam Dong Province; *M. annamensis*: 8, Chu Pan Phan Mt., Chu Yang Sin N. P., Krong Bong District, Dak Lak Province; 10, Road from Hon Giao to Khanh Vinh, Khanh Vinh District, Khanh Hoa Province; 11, Sui Cat [Sui Kat], Khanh Hoa Province (Smith, 1923); 13, Hon Ba Mt., Cam Lam District, Khanh Hoa Province; 16, Giang Ly station, Bidoup – Nui Ba N. P., Lac Duong District, Lam Dong Province; 19, D'Ran, Don Duong District, Lam Dong Province (Smith, 1923); *M. pulchella* sp. nov.: 9, Hon Giao Mt., border of Lac Duong District, Lam Dong Province and Khanh Vinh District, Khanh Hoa Province; 14, the road from Long Lanh to Hon Giao, Lac Duong District, Lam Dong Province; *M. fusca*: 18, Dalat, Lam Dong Province (Andersson, 1942); *M. minuta* sp. nov.: 20, Cat Tien N. P., Tan Phu District, Dong Nai Province; 21, Ma Da forestry, Vinh Cuu (Dong Nai) Reserve, Vinh Cuu District, Dong Nai Province (Tarkhnishvili, 1994, 1995).

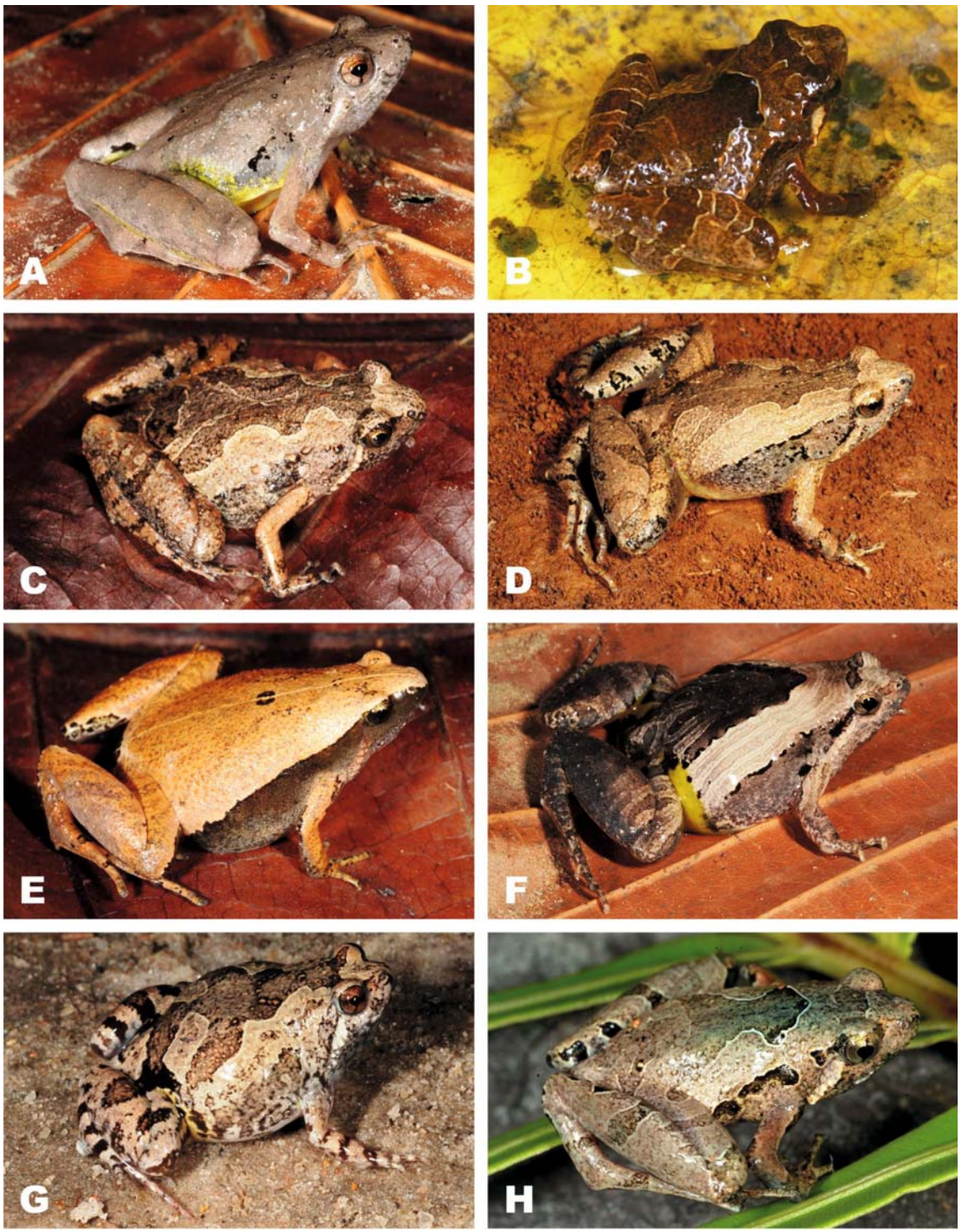

Fig. 2. Currently recognized *Microhyla* species of Vietnam (dorsolateral view, not to scale; except: *M. fusca* and *M. nanapollexa* known from single specimens are not shown; for *M. annamensis* see Fig. 3): (A) *M. berdmorei*, adult female from Lo Go – Xa Mat National Park, Tay Ninh Province, Vietnam; (B) *M. pulverata*, adult male from Buon Luoi, Gia Lai Province, Vietnam (topotype); (C) *M. butleri*, adult male from Loc Bac forestry, Lam Dong Province, Vietnam; (D) *M. fissipes*, adult male from Loc Bac forestry, Lam Dong Province, Vietnam; (E) *M. heymonsi*, adult male from Loc Bac forestry, Lam Dong Province, Vietnam; (F) *M. pulchra*, adult female from Lo Go – Xa Mat National Park, Tay Ninh Province, Vietnam; (G) *M. picta*, adult male from Binh Chau – Phuoc Buu National Park, Ba Ria – Vung Tau Province, Vietnam; (H) *M. marmorata*, adult male from Huong Lap, Quang Tri Province. Photos A, C – G by N. A. Poyarkov, photos B, H by N. L. Orlov.

imens, including the type series and referring materials are stored in the herpetological collections of the Zoological Museum of Moscow State University (ZMMU) in Moscow, Russia; Zoological Institute of the Russian Academy of Sciences (ZISP) in St. Petersburg, Russia; the University of Science (UNS) in Ho Chi Minh City, Vietnam; Institute of Ecology and Biological Recourses (IEBR) in Hanoi, Vietnam; and the Zoologisches Forschungsmuseum Alexander Koenig (ZFMK) in Bonn, Germany.

Adult morphology. Specimen sex was determined by dissection. Toe-webbing formulae are given following Savage (1975). For postmetamorphic specimens, all measurements were taken using digital calipers under the light dissecting microscope OLYMPUS to the nearest 0.1 mm. We took 19 body measurements, following Matsui (1984, 1994, 2011) and Matsui et al. (2013): (1) snout-vent length (SVL; measured from the tip of the snout to cloaca); (2) head length (HL; measured from tip of snout to hind border of jaw angle, but not measured parallel with the median line as done by Matsui, 2011); (3) snout length (SL; measured from the anterior corner of eye to the tip of snout); (4) eye length (EL; measured as the distance between the anterior and posterior corners of the eye); (5) nostril-eyelid length (N-EL; measured as the distance between the anterior corner of eye and the nostril center); (6) head width (HW; measured as the maximum width of the head on the level of mouth angles in ventral view); (7) internarial distance (IND; measured as the distance between centers of nostrils); (8) interorbital distance (IOD; measured as the shortest distance between the medial edges of eyeballs in dorsal view); (9) upper eyelid width (UEW; measured as the widest distance from the medial edge of eyeball to the lateral edge of the upper eyelid); (10) forelimb length (FLL; measured as length of straightened forelimb froBinh Chau –a to tip of third finger); (11) lower arm and hand length (LAL; measured as distance from elbow to tip of third finger); (12) first finger length (1FL; measured from distal end of inner palmar (metacarpal) tubercle to finger tip); (13) hand length (HAL; measured from proximal end of outer palmar (metacarpal) tubercle to tip of third finger); (14) inner palmar tubercle length (IPTL; measured as maximal distance from proximal to distal ends of inner palmar tubercle); (15) outer palmar tubercle length (OPTL; measured as maximal diameter of outer palmar tubercle); (16) hindlimb length (HLL; measured as length of straightened hindlimb from groin to tip of fourth toe); (17) tibia length (TL; taken as distance between the knee and tibiotarsal articulation); (18) foot length (FL; measured from distal end of tibia to tip of toe IV); and (19) inner metatarsal tubercle length (IMTL; taken as maximal diameter of inner metatarsal tubercle). Additionally, we also measured the following: (20) first toe length (1TOEL), from distal end of inner metatarsal tubercle to tip of first toe; (21) outer metatarsal tubercle length (OMTL); (22) first finger width (1FW), measured at the distal phalanx; (23 – 25) finger disk diameters (2 – 4FDW); (26 – 30) toe disk diameters (1 – 5TDW); and (31 – 36) finger lengths (1 – 3FLO, 2 – 4FLI), for outer side (O) of the first, inner side (I) of the fourth, and both sides of the remaining fingers, measured between tip and the junction of the neighboring finger. For comparison purposes, we examined available museum specimens of described taxa of the genus *Microhyla* (see *Appendix*). For remaining taxa we accumulated all available data from the literature (see Table 3). The diagnosis of the genus *Microhyla* and morphological characters chosen for comparison were taken from Boulenger (1900), Smith (1923), Parker (1928, 1934), Bourret (1942), Parker and Osman-Hill (1949), Inger (1966, 1989), Inger and Frogner (1979), Manthey and Grossmann (1997), Malkmus et al. (2002), Bain and Nguyen (2004), Matsui (2011), Matsui et al. (2013), Hasan et al. (2014).

Larval morphology. Collected tadpoles were staged according to Gosner (1960). Tadpole morphology was examined using a LEICA EZ4 dissecting stereo microscope (Germany) with a digital photo attachment. Original drawings were done by A. B. Vassilieva based on a series of photographs. Tadpole descriptions and morphometrics mainly followed Bowatte and Meegaskumbura (2011), Matsui (2011) and Chou and Lin (1997) and included the following measurements (taken with the use of digital calipers and a microscopic scale bar to the nearest 0.1 mm): total length (TL), body length (BL), tail length measured from tail tip to rear end of body (TaL), maximal body width (BW), maximal body height (BH), maximal tail height (TH), snout-vent length measured from snout tip to the most posterior edge of vent tube (SVL), snout-spiracle length (SSp), maximal upper fin height (UF), maximal lower fin height (LF), interpupilar distance (IP), pupillo-rostral distance (PR), horizontal eye diameter (ED), and oral disk width (ODW).

Species identification of larval specimens was confirmed by COI DNA-barcoding following standard protocols for amphibians (for used primers and PCR conditions see Smith et al., 2008; Che et al., 2012; Murphy et al., 2013), and by direct observations: rearing of tadpoles from eggs obtained from adults of certain *Microhyla* species or by rearing of wild-caught tadpoles in laboratory conditions till metamorphosis.

RESULTS

Systematics

The following species are assigned to the genus *Microhyla* by: absence of vomerine teeth; absent omosternum; a narrow and elliptical tongue; tympanum being hidden by skin; free fingers; the lack of small spine-like projections of skin at heel and elbow; the belly lacking a brown network; underside of fingers lacking greatly enlarged tubercles; snout being less short than twice of the diameter of eye; the inner metatarsal tubercle being low, not shovel-like; eyes being comparatively small and not protuberant in dorsal view (Inger, 1966; Dubois, 1987; Matsui et al., 2013; Hasan et al., 2014).

***Microhyla annamensis* Smith, 1923**
Figs. 3 – 6

Synonymy. *Microhyla annamensis* Smith, 1923: 47.

Holotype. BMNH 1923.5. 14.10 according to Parker (1934): 130; "the authors number 2412" changed to BMNH 1947.2.11.50 according to Bain and Nguyen, 2004: 516. Type locality: "Sui Kat, 1000 meters altitude, Langbian Plateau, S. Annam," southern Vietnam.

Microhyla (*Microhyla*) *annamensis* — Dubois, 1987, *Alytes*, 6: 3.

Microhyla sp. 2 — Poyarkov [Paiarkov] and Vassilieva, 2011: pp. 175, 203; Fig. 5.9.

Adult morphology. The materials of *M. annamensis* studied in this paper are listed in the *Appendix*. Variation in size and body proportions in this species are given in Table 1. Altogether we studied 42 adult specimens, among them 27 males and 15 females. Adult specimens in life are shown in Fig. 3. In general the studied series demonstrate high similarity with the holotype described in detail by Bain and Nguyen (2004). Differences are minor and may be explained by intraspecific variation of morphological traits as well as by the long term preservation of the type series.

Comparison of recently collected *M. annamensis* specimens with the holotype and previous descriptions of this species:

1) According to Bain and Nguyen (2004), the holotype, an adult female, has SVL = 20.0 mm. Observed variation in size and body proportions in recently collected specimens is given in Table 1. Females are larger than males: SVL 18.2 – 22.6 mm in females ($N = 15$) (Fig. 3A); SVL 12.2 – 19.8 mm in males ($N = 27$) (Figs. 3B). Thus the body size of the type specimen fits well within the variation of female SVL in our series.

2) Bain and Nguyen (2004) describe the holotype as "moderately slender"; in our opinion the habitus of the species is rather moderately stocky. Possibly these differences can be explained due to holotype preservation. Bain and Nguyen (2004) indicate that the tibiotarsal articulation of the holotype in adpressed limbs reaches to snout or just beyond, whereas in our series heels of adpressed limbs normally reached well beyond the snout. This difference also can be explained due to long term preservation of the holotype in ethanol.

3) *M. annamensis* is a rough-skinned frog; in the original description Smith (1923) noted that in the specimens of the type series the "warty condition of the skin is variable but is always present in some degree." According to Bain and Nguyen (2004), the holotype of *M. annamensis* (a female) has a rough dorsum with tubercles on the back, head, upper eyelid, supratympanic fold, and limbs. In our series the dorsal skin can vary from granular in females (Fig. 3A) to strongly tubercular in breeding males (Fig. 3B); males always show a more tubercular dorsum than females; the ventral skin is smooth in both sexes (Fig. 3C).

4) Patterns of hand and foot morphology, including development of digital disks and extant of webbing in our series (see Fig. 4) is highly similar to that of the holotype. There are some minor differences in webbing between the holotype described by Bain and Nguyen (2004) and our series. Based on the photo published by Bain and Nguyen (2004) the webbing formula of the holotype is as follows: I 1 – 1¾ II 1 – 2¼ III 1 – 2 IV 2 – 1 V; while the webbing formula of ZMMU A-5075 (NAP-01811), a male from our series is: I 1 – 2¼ II 1 – 2½ III 1½ – 2¾ IV 3 – 1 V. Quite substantial differences in foot webbing between the *M. annamensis* holotype and the series in hands possibly can be explained by the intraspecific variation of local populations and sexual variation, since females in our series also tend to have less developed webbing than males.

5) Bain and Nguyen (2004) report a single metatarsal tubercle for the holotype of *M. annamensis*. However, in our series we found a significant variation in the degree of development of the outer metatarsal tubercle. It may be present in various conditions: usually it is present and prominent (60% of specimens examined, as in Fig. 4B), in some specimens it is small and flat (15%), or totally absent (35%); no correlation between the degree of outer metatarsal tubercle development and sex or reproductive state was found.

6) Coloration of the *M. annamensis* holotype was described by Smith (1923) and specified by Parker (1934) in his monograph: "Gray-brown above, with a short, black streak above each shoulder; a V-shaped dark spot on the scapular region and, sometimes, a few indistinct dark spots posteriorly; usually there is a triangular dark spot between the eyes, and a light line from beneath the eye to the fore-limb. Limbs with more or less

TABLE 1. Main Morphometric Parameters of Adults of New *Microhyla* Species and *M. annamensis* from Southern Vietnam (in mm; for abbreviations see the text)

Sex	*N*	SVL	HL	SL	EL	N-EL	HW	IND
				Microhyla pineticola sp. nov. (*N* = 22)				
♂	14	18.34 ± 0.76 (17.2 – 19.5)	6.01 ± 0.41 (5.2 – 6.7)	2.47 ± 0.35 (1.5 – 3.0)	2.02 ± 0.23 (1.5 – 2.3)	1.54 ± 0.15 (1.3 – 1.7)	6.17 ± 0.33 (5.5 – 6.7)	1.84 ± 0.11 (1.6 – 2.0)
♀	9	19.36 ± 3.94 (10.3 – 24.3)	6.28 ± 1.05 (3.7 – 7.4)	2.73 ± 0.58 (1.8 – 3.7)	2.10 ± 0.29 (1.5 – 2.5)	1.58 ± 0.35 (1.0 – 2.1)	6.92 ± 0.79 (5.6 – 8.4)	1.87 ± 0.28 (1.3 – 2.3)
				Microhyla pulchella sp. nov. (*N* = 39)				
♂	17	17.40 ± 1.86 (14.7 – 21.6)	5.84 ± 0.52 (5.0 – 7.1)	2.35 ± 0.20 (2.1 – 3.0)	2.09 ± 0.28 (1.7 – 2.9)	1.30 ± 0.19 (1.1 – 1.8)	6.19 ± 0.58 (5.4 – 7.8)	1.64 ± 0.16 (1.5 – 2.1)
♀	22	23.27 ± 1.64 (18.1 – 25.8)	7.23 ± 0.65 (5.3 – 8.4)	2.89 ± 0.26 (2.1 – 3.3)	2.42 ± 0.32 (1.8 – 2.9)	1.56 ± 0.16 (1.3 – 1.9)	7.33 ± 0.67 (5.0 – 8.1)	2.03 ± 0.19 (1.5 – 2.3)
				Microhyla minuta sp. nov. (*N* = 14)				
♂	11	15.26 ± 0.38 (14.6 – 15.9)	5.29 ± 0.18 (5.0 – 5.6)	1.93 ± 0.21 (1.6 – 2.3)	1.79 ± 0.10 (1.6 – 2.0)	1.13 ± 0.12 (0.9 – 1.3)	4.84 ± 0.18 (4.6 – 5.2)	1.26 ± 0.12 (1.1 – 1.5)
♀	3	16.64 ± 0.86 (15.7 – 17.2)	5.36 ± 0.73 (4.6 – 6.0)	2.28 ± 0.19 (2.1 – 2.4)	1.87 ± 0.36 (1.5 – 2.1)	1.19 ± 0.10 (1.1 – 1.3)	5.04 ± 0.29 (4.8 – 5.4)	1.45 ± 0.03 (1.4 – 1.5)
				Microhyla darevskii sp. nov. (*N* = 5)				
♂	5	30.04 ± 2.11 (27.0 – 32.6)	9.85 ± 0.24 (9.6 – 10.1)	4.36 ± 0.25 (4.2 – 4.7)	3.46 ± 0.11 (3.4 – 3.6)	2.26 ± 0.10 (2.1 – 2.4)	10.99 ± 0.29 (10.6 – 11.3)	2.95 ± 0.15 (2.7 – 3.1)
				Microhyla arboricola sp. nov. (*N* = 13)				
♂	9	14.11 ± 0.71 (13.2 – 15.0)	4.72 ± 0.27 (4.4 – 5.1)	2.08 ± 0.20 (1.8 – 2.3)	1.97 ± 0.09 (1.8 – 2.1)	1.15 ± 0.08 (1.1 – 1.3)	5.21 ± 0.26 (4.9 – 5.6)	1.61 ± 0.17 (1.4 – 1.9)
♀	4	16.44 ± 0.74 (15.9 – 17.0)	5.6 ± 0.10 (5.5 – 5.7)	2.29 ± 0.28 (2.1 – 2.5)	1.98 ± 0.05 (1.9 – 2.0)	1.07 ± 0.01 (1.1 – 1.1)	5.45 ± 0.00 (5.5 – 5.5)	2.01 ± 0.01 (2.0 – 2.0)
				Microhyla annamensis Smith, 1923 (*N* = 42)				
♂	27	17.37 ± 1.81 (12.2 – 19.8)	5.90 ± 0.76 (4.5 – 8.0)	2.51 ± 0.18 (2.0 – 2.9)	2.13 ± 0.17 (1.7 – 2.4)	1.47 ± 0.15 (1.1 – 1.7)	6.44 ± 0.70 (4.9 – 7.7)	1.77 ± 0.17 (1.3 – 2.1)
♀	15	19.58 ± 1.23 (18.2 – 22.6)	6.29 ± 0.46 (5.7 – 7.3)	2.68 ± 0.24 (2.3 – 3.2)	2.22 ± 0.12 (2.1 – 2.5)	1.57 ± 0.15 (1.4 – 1.9)	6.81 ± 0.36 (6.0 – 7.5)	1.93 ± 0.11 (1.6 – 2.1)

Sex	*N*	IOD	UEW	FLL	LAL	HAL	1FL	IPTL	OPTL
					Microhyla pineticola sp. nov. (*N* = 22)				
♂	14	2.34 ± 0.19 (2.1 – 2.8)	1.20 ± 0.14 (1.0 – 1.5)	10.78 ± 0.64 (9.5 – 12.1)	8.06 ± 0.37 (7.4 – 8.8)	4.61 ± 0.24 (4.2 – 5.0)	1.10 ± 0.16 (0.9 – 1.4)	0.60 ± 0.09 (0.4 – 0.8)	0.84 ± 0.08 (0.7 – 1.0)
♀	9	2.35 ± 0.62 (0.7 – 2.9)	1.21 ± 0.20 (0.9 – 1.5)	11.00 ± 2.03 (5.9 – 13.3)	8.50 ± 1.74 (4.6 – 10.5)	4.83 ± 0.90 (2.7 – 5.8)	1.23 ± 0.32 (0.7 – 1.9)	0.69 ± 0.16 (0.5 – 1.0)	0.88 ± 0.07 (0.6 – 1.0)
					Microhyla pulchella sp. nov. (*N* = 39)				
♂	17	2.37 ± 0.19 (2.1 – 2.8)	1.12 ± 0.18 (0.8 – 1.5)	12.96 ± 1.58 (10.0 – 15.5)	9.77 ± 1.20 (7.4 – 11.4)	5.54 ± 0.75 (4.1 – 6.4)	1.05 ± 0.15 (0.7 – 1.3)	0.70 ± 0.12 (0.6 – 1.1)	0.81 ± 0.11 (0.7 – 1.0)
♀	22	2.74 ± 0.26 (1.9 – 3.0)	1.45 ± 0.17 (1.0 – 1.7)	14.70 ± 1.20 (11.7 – 17.1)	11.06 ± 0.80 (8.60 – 12.9)	6.13 ± 0.45 (4.5 – 7.0)	1.30 ± 0.19 (1.0 – 1.7)	0.80 ± 0.12 (0.5 – 1.1)	1.06 ± 0.16 (0.8 – 1.3)
					Microhyla minuta sp. nov. (*N* = 14)				
♂	11	1.74 ± 0.18 (1.5 – 2.0)	0.95 ± 0.14 (0.8 – 1.2)	9.15 ± 0.27 (8.4 – 9.5)	6.76 ± 0.39 (6.1 – 7.2)	4.15 ± 0.15 (3.8 – 4.3)	0.81 ± 0.10 (0.7 – 1.0)	0.42 ± 0.05 (0.4 – 0.5)	0.55 ± 0.05 (0.5 – 0.6)
♀	3	1.74 ± 0.08 (1.7 – 1.8)	1.04 ± 0.09 (1.0 – 1.1)	9.40 ± 1.63 (7.6 – 10.7)	7.21 ± 0.27 (6.9 – 7.4)	4.19 ± 0.10 (4.1 – 4.3)	0.88 ± 0.05 (0.8 – 0.9)	0.44 ± 0.11 (0.3 – 0.5)	0.62 ± 0.12 (0.5 – 0.7)
					Microhyla darevskii sp. nov. (*N* = 5)				
♂	5	4.37 ± 0.16 (4.2 – 4.6)	2.35 ± 0.12 (2.2 – 2.5)	18.52 ± 0.28 (18.1 – 18.8)	12.78 ± 0.37 (12.2 – 13.2)	8.17 ± 0.17 (8.0 – 8.3)	3.43 ± 0.18 (3.1 – 3.6)	1.27 ± 0.14 (1.1 – 1.4)	1.74 ± 0.22 (1.5 – 2.0)
					Microhyla arboricola sp. nov. (*N* = 13)				
♂	9	2.04 ± 0.13 (1.9 – 2.2)	1.03 ± 0.17 (0.9 – 1.2)	7.85 ± 0.46 (7.2 – 8.4)	6.44 ± 0.51 (5.7 – 6.9)	3.65 ± 0.23 (3.4 – 3.9)	0.69 ± 0.08 (0.6 – 0.8)	0.58 ± 0.09 (0.5 – 0.6)	0.60 ± 0.17 (0.4 – 0.8)
♀	4	2.17 ± 0.04 (2.1 – 2.2)	1.14 ± 0.04 (1.1 – 1.2)	8.85 ± 0.21 (8.7 – 9.0)	6.57 ± 0.03 (6.6 – 6.6)	3.69 ± 0.24 (3.5 – 3.9)	0.75 ± 0.13 (0.7 – 0.8)	0.56 ± 0.01 (0.6 – 0.6)	0.56 ± 0.08 (0.5 – 0.6)
					Microhyla annamensis Smith, 1923 (*N* = 42)				
♂	27	2.40 ± 0.20 (2.0 – 2.7)	1.35 ± 0.17 (1.0 – 1.7)	11.45 ± 1.32 (7.0 – 13.0)	8.80 ± 0.97 (5.6 – 9.9)	4.85 ± 0.61 (3.3 – 5.6)	0.91 ± 0.14 (0.7 – 1.2)	0.65 ± 0.11 (0.4 – 0.9)	0.89 ± 0.12 (0.7 – 1.1)
♀	15	2.55 ± 0.16 (2.3 – 2.8)	1.48 ± 0.18 (1.2 – 1.8)	12.21 ± 0.81 (10.4 – 13.9)	9.82 ± 0.75 (8.6 – 11.5)	5.30 ± 0.50 (4.5 – 6.5)	1.05 ± 0.17 (0.8 – 1.5)	0.77 ± 0.12 (0.6 – 1.0)	0.99 ± 0.15 (0.7 – 1.3)

TABLE 1 (continued)

Sex	*N*	3FDD	HLL	TL	FL	IMTL	1TOEL	OMTL	3TDD
				Microhyla pineticola sp. nov. (*N* = 22)					
♂	14	0.46 ± 0.07 (0.4 – 0.6)	32.63 ± 1.44 (30.0 – 35.4)	11.08 ± 0.46 (10.0 – 11.7)	11.02 ± 0.55 (10.2 – 11.7)	0.77 ± 0.13 (0.6 – 1.0)	1.76 ± 0.16 (1.3 – 2.0)	0.51 ± 0.09 (0.4 – 0.7)	0.76 ± 0.06 (0.6 – 0.9)
♀	9	0.52 ± 0.07 (0.4 – 0.8)	33.37 ± 6.23 (17.5 – 40.0)	11.90 ± 2.44 (5.8 – 14.4)	11.45 ± 2.31 (5.8 – 13.7)	0.75 ± 0.15 (0.4 – 0.9)	1.75 ± 0.44 (0.9 – 2.4)	0.54 ± 0.10 (0.4 – 0.8)	0.84 ± 0.19 (0.4 – 1.2)
				Microhyla pulchella sp. nov. (*N* = 39)					
♂	17	0.63 ± 0.15 (0.4 – 0.9)	32.64 ± 2.69 (28.0 – 37.9)	11.04 ± 1.01 (9.3 – 13.2)	10.17 ± 1.07 (8.1 – 12.5)	0.76 ± 0.06 (0.7 – 0.9)	1.79 ± 0.21 (1.4 – 2.2)	0.77 ± 0.41 (0.4 – 1.2)	0.93 ± 0.13 (0.7 – 1.2)
♀	22	0.66 ± 0.09 (0.5 – 0.8)	40.38 ± 2.63 (30.4 – 44.5)	14.03 ± 0.92 (10.6 – 15.8)	12.92 ± 0.77 (10.9 – 14.8)	0.92 ± 0.17 (0.7 – 1.3)	2.45 ± 0.23 (1.9 – 3.1)	0.77 ± 0.33 (0.4 – 1.3)	1.24 ± 0.11 (1.0 – 1.4)
				Microhyla minuta sp. nov. (*N* = 14)					
♂	11	0.42 ± 0.07 (0.3 – 0.5)	25.59 ± 1.05 (23.6 – 26.9)	8.42 ± 0.20 (8.1 – 8.8)	9.10 ± 0.34 (8.4 – 9.6)	0.52 ± 0.07 (0.4 – 0.7)	1.39 ± 0.10 (1.2 – 1.6)	0.37 ± 0.04 (0.3 – 0.4)	0.54 ± 0.07 (0.4 – 0.6)
♀	3	0.51 ± 0.11 (0.4 – 0.6)	28.27 ± 2.57 (25.3 – 30.1)	9.58 ± 0.93 (8.7 – 10.5)	10.04 ± 0.86 (9.1 – 10.7)	0.58 ± 0.02 (0.6 – 0.6)	1.59 ± 0.26 (1.3 – 1.8)	0.43 ± 0.03 (0.4 – 0.5)	0.65 ± 0.10 (0.6 – 0.8)
				Microhyla darevskii sp. nov. (*N* = 5)					
♂	5	0.68 ± 0.12 (0.5 – 0.8)	57.54 ± 3.69 (51.3 – 60.6)	18.90 ± 1.16 (17.0 – 19.8)	22.05 ± 1.57 (19.5 – 23.5)	1.37 ± 0.25 (1.1 – 1.7)	3.53 ± 0.44 (3.0 – 4.0)	0.77 ± 0.13 (0.6 – 0.9)	1.11 ± 0.06 (1.0 – 1.2)
				Microhyla arboricola sp. nov. (*N* = 13)					
♂	9	0.60 ± 0.05 (0.5 – 0.7)	24.93 ± 0.83 (23.9 – 25.9)	8.69 ± 0.17 (8.4 – 8.8)	7.41 ± 0.28 (7.0 – 7.7)	0.56 ± 0.08 (0.4 – 0.6)	1.14 ± 0.11 (1.0 – 1.2)	—	0.66 ± 0.04 (0.6 – 0.7)
♀	4	0.51 ± 0.08 (0.5 – 0.6)	26.42 ± 0.14 (26.3 – 26.5)	9.78 ± 0.49 (9.4 – 10.1)	8.57 ± 0.51 (8.2 – 8.9)	0.70 ± 0.06 (0.7 – 0.7)	1.25 ± 0.03 (1.2 – 1.3)	—	0.74 ± 0.04 (0.7 – 0.7)
				Microhyla annamensis Smith, 1923 (*N* = 42)					
♂	27	0.58 ± 0.11 (0.4 – 0.8)	32.15+3.14 (21.4 – 37.5)	11.10 ± 1.04 (8.1 – 13.0)	9.93 ± 1.08 (6.9 – 11.5)	0.71 ± 0.11 (0.6 – 1.0)	1.72 ± 0.23 (1.2 – 2.1)	1.10 ± 0.25 (0.4 – 1.4)	0.81 ± 0.13 (0.5 – 1.0)
♀	15	0.68 ± 0.11 (0.5 – 0.9)	35.38 ± 2.92 (29.7 – 41.4)	12.17 ± 0.97 (10.5 – 14.4)	11.01 ± 0.83 (9.4 – 13.1)	0.79 ± 0.09 (0.6 – 1.0)	1.95 ± 0.23 (1.4 – 2.3)	1.14 ± 0.24 (0.8 – 1.4)	0.88 ± 0.13 (0.7 – 1.1)

distinct black cross-bars. Yellow beneath, more or less thickly brown dusted." This description fits well with the variation in coloration of our series. Background color can vary from dark brown (Fig. 3A) to gray-beige (Fig. 3B) or lighter. Dark spots above shoulders can have distinct light-brownish thin bordering (Fig. 3A) or are lacking such a bordering (Fig. 3B). Males often show orange or reddish tints in coloration of dorsal surfaces of head, scapular area and limbs (Fig. 3B). The chevron-shaped dark scapular spot can be small and narrow confined to only the scapular area (Fig. 3B) or extend towards groin forming an inverted Ψ-shaped dark figure. Ventral coloration is usually darker than stated in the original description — brownish to dark brick-brown with orange or beige irregular mottling; chin is usually darker.

Diagnosis. Based on the variation observed in recently collected specimens we provide a renewed diagnosis for *Microhyla annamensis* Smith, 1923: *Microhyla annamensis* Smith, 1923 is characterized by a combination of the following characters: (1) a medium-sized form of *Microhyla*, body stocky; (2) SVL of adult males 15.2 – 19.8 mm, mean 17.4 mm; SVL of adult females 18.2 – 22.6 mm, mean 19.6 mm; (3) dorsum always warty, usually strongly tubercular, shagreened ventrally; (4) head short and triangular, snout bluntly rounded in profile; (5) finger I short, less than one-half the length of finger II; (6) tips of three outer fingers weakly dilated, forming weak disks, dorsally with a distinct median longitudinal groove; (7) tips of all toes distinctly dilated into disks, dorsally with a sharp median longitudinal groove producing the appearance of two scutes, toe disks expanded, less than twice the width of phalanges; (8) outer metacarpal tubercle single, flat, indistinct; inner metacarpal tubercle rounded; (9) tibiotarsal articulation at straightened limb adpressed to body reaching well beyond snout tip; (10) webbing broad, reaching toe disks; on toe IV, as well as on preaxial side of toes II and III reaching disks as a fringe, webbing formula: I 1 – 2¼ II 1 – 2½ III 1½ – 2¾ IV 3 – 1 V; inner and outer metatarsal tubercles present, inner elongated, oval-shaped and prominent, outer flat, rounded and often totally absent; (11) upper eyelid without supraciliary spines; (12) canthus rostralis distinct, no dark stripes, top of snout not differentiated in color from dark interorbital bar; dark spot above each shoulder; no distinct dark dorsolateral stripes; faint beige stripe extending from rear corner of eye to axilla; (13) light thin vertebral stripe absent; (14) dorsum

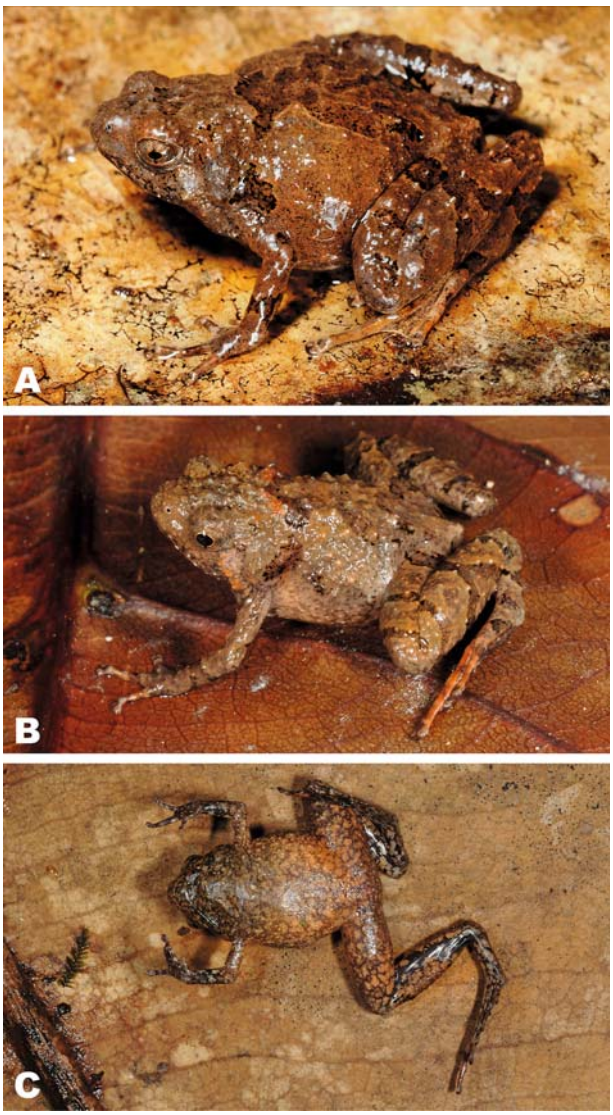

Fig. 3. Specimens of *M. annamensis* from southern Vietnam in life: (A) female from environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam, dorsolateral view; (B) male from Chu Pan Phan Mt., Chu Yang Sin National Park, Dak Lak Province, Vietnam, dorsolateral view; (C) male from environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam, ventral view. Photos by N. A. Poyarkov.

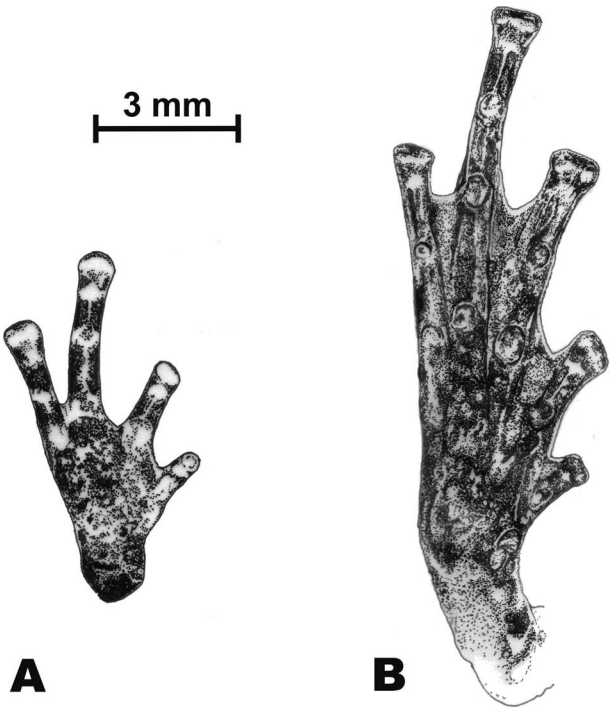

Fig. 4. *M. annamensis* from southern Vietnam: (A) palmar view of the right hand; (B) plantar view of the right foot. Drawings by V. D. Kretova.

with dark chevron, sometimes forming larger figure in shape of inverted "Y" or "Ψ"; (15) flanks and dorsum show similar coloration, no dark bands on flanks; (16) chin dark-brown with slight yellowish mottling, belly brownish with orange or beige mottling; (17) larvae with terminal oral disk, upper labium with prominent medial part and deflected lateral lobes; lower labium narrow, U-shaped, bordered with a thickened marginal ridge; tail of moderate length, approximately one and a half body lengths, with weakly developed muscular part; tail tip not forming terminal filament.

Tadpole description. Studied material. Tadpoles (20 specimens; stages 26 – 38; ZMMU A-5077; field number NAP-02478; description based on 13 specimens; stages 26 – 38) were collected on 11 July 2011 in a small shallow backwater on a cascade forest stream in Bidoup – Nui Ba National Park (coordinates 12°10′24.24″ N 108°41′54.96″ E, elevation 1495 m a.s.l.). Tadpoles were swimming within the water column forming loose groups of up to several tens of individuals.

General morphology. Tadpole external morphology is shown in Figs. 5 and 6. Variation in size and body proportions of tadpoles is given in Table 2.

In dorsal view (Figs. 5A and 6A), body oval, with maximum width at gills level about 0.71 of body length (BW/BL 0.69 – 0.76); snout rounded. From lateral view (Figs. 5B and 6B), body compressed dorsoventrally, flattened above and rounded below. Tail of moderate length, approximately one and a half of body length, mean TaL/BL = 1.52 (1.33 – 1.68), with muscular part weakly developed; tail tip not forming a terminal filament. Height of the muscular portion at tail base nearly equal to the height of lower fin. Upper fin not extending on the trunk and reaching maximum height in the second third

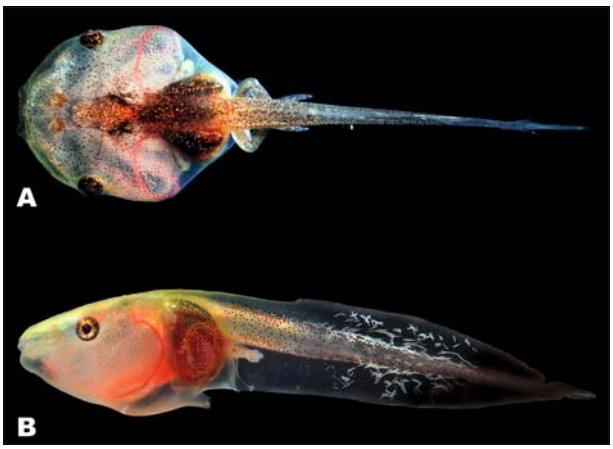

Fig. 5. Tadpoles of *M. annamensis* (stages 35 – 37) in life: (A) lateral view; (B) dorsal view. Photos by E. A. Galoyan.

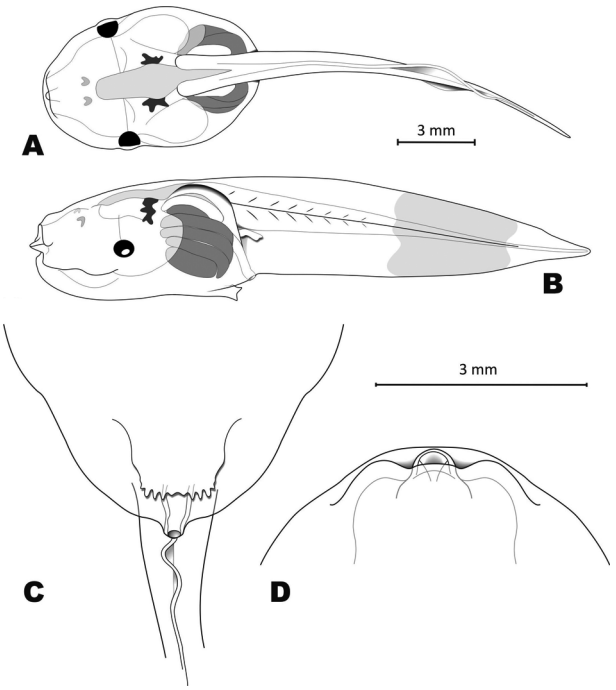

Fig. 6. External morphology of *M. annamensis* tadpole (Stage 32): (A) dorsal view; (B) lateral view; (C) vent area; (D) mouth area (dorsal view). Drawings by A. B. Vassilieva.

of the tail; lower fin highest in the medial third of the tail, it's maximal height greater than that of the upper fin. Spiracle medial, free portion forming a relatively short wide membrane with the serrate edge ending near the caudal end of belly (see Fig. 6C). Vent tube almost vertical, opening medially at the beginning of the lower tail fin.

Eyes lateral, relatively small (mean eye diameter about 0.12 of body length; ED/BL 0.10 – 0.14); pupils oriented laterally and slightly ventrally, visible from below. Oral disk terminal (see Figs. 5 and 6A, D); upper labium with prominent medial part and deflected lateral lobes; lower labium narrow, U-shaped, bordered with a thickened marginal ridge. Keratinized elements (denticles, beak) absent. Nostrils not opened at stages available. Lateral line system not visible.

Coloration in life. Body almost transparent, pinkish; red gills and dark intestinal loops very well distinct. Eyes black; light-brown olfactory sacs visible through the skin. Small chromatophores aggregating along the medial line of the dorsal trunk surface and forming an elongate gray patch; pigmented dorsal coelomic lining forming two short dark stripes along tail muscles extending on the trunk. Tail stem marked by scattered chromatophores on its dorsal and lateral sides. Tail fins transparent in the proximal half of the tail and tail tip; scattered chromatophores forming a distinctive dark patch in the distal part of the fins.

Natural history notes. The species was encountered in montane evergreen polydominant tropical forests with a predominance of Fagaceae (*Lithocarpus*, *Castanopsis*, *Quercus*), Magnoliaceae (*Manglietia*, *Michelia*), Hamamelidaceae (*Symigtonia*), Elaeocarpaceae (*Elaeocarpus*, *Sloanea*) and other tree species (Kuznetsov et al., 2006), as well as in mixed forests with presence of *Pinus kesyia* (Pinaceae) and *Fokienia hodginsii* (Cupressaceae) at elevations from 1000 to ~2000 m a.s.l. (for typical habitat see Fig. 7A). All frogs were found on the ground, at day or night.

Breeding. During the field surveys in July 2011 on Bidoup Mt. and in March and April 2012 – 2013 on Chu Pan Phan Mt. (Chu Yang Sin National Park), breeding activity was observed after heavy rains; gravid females, calling males and couples in amplexus were found on the forest floor near forest streams. Spawning was observed in shallow pools. Eggs are small (1.0 mm in diameter), pigmented, floating on water surface in small rafts. Tadpoles were observed in still temporary ponds and calm stream backwaters.

Syntopic batrachofauna. In the montane evergreen forests of Bidoup – Nui Ba (Fig. 7A) and Chu Yang Sin national parks, *M. annamensis* co-occurs with following anuran species (see Poyarkov and Vassilieva, 2011): *Ophryophryne* cf. *hansi* Ohler, 2003, *Ingerophrynus galeatus* (Günther, 1864), *Xenophrys major* (Boulenger, 1908), *Hylarana montivaga* (Smith, 1921), *Hylarana attigua* (Inger, Orlov et Darevsky, 1999), *Microhyla arboricola* sp. nov., *Microhyla pineticola* sp. nov., *Microhyla pulchella* sp. nov., *Raorchestes gryllus* (Smith, 1924), *Rhacophorus annamensis* Smith, 1924, *Rhacophorus calcaneus* Smith, 1924, *Rhacophorus vampyrus*

TABLE 2. Main Morphometric Parameters of Tadpoles of New *Microhyla* Species and *M. annamensis* from Southern Vietnam (in mm)

Stage	TL	BL	TaL	BW	BH	TH	SVL	SSp	UF	LF	IP	PR	ED	ODW
Microhyla annamensis Smith, 1923 ($N = 10$)														
26	13.9	6.0	7.9	4.2	3.3	3.1	6.2	6.0	1.1	1.1	4.0	2.5	0.7	1.2
27	14.0	6.0	8.0	4.2	3.2	3.1	6.2	6.0	1.2	1.3	4.0	2.6	0.7	1.2
27	15.4	6.1	9.3	4.2	3.4	2.6	6.4	6.0	1.1	1.2	4.0	2.6	0.7	1.3
29	16.4	6.2	10.1	4.8	3.8	3.0	6.4	6.0	1.1	1.2	4.6	2.8	0.7	1.5
31	17.5	7.0	10.5	5.1	4.0	3.2	8.0	6.9	1.1	1.3	4.8	2.9	0.7	1.5
31	18.0	7.3	10.7	5.1	4.0	3.3	8.0	7.1	1.2	1.5	4.7	3.0	0.7	1.4
32	18.2	7.1	11.1	5.1	3.8	3.2	7.5	6.9	1.2	1.5	4.9	3.0	0.8	1.9
36	19.2	7.4	11.8	5.2	3.5	3.3	7.9	6.8	1.2	1.5	4.9	3.2	0.9	1.9
36	19.8	7.5	12.3	5.3	4.2	3.3	8.2	7.2	1.3	1.5	5.1	3.0	0.8	1.9
38	19.3	7.2	12.1	5.1	4.0	3.5	7.7	6.8	1.2	1.4	5.1	3.0	0.9	2.1
Microhyla pineticola sp. nov. ($N = 10$)														
25	12.2	4.8	7.4	3.5	3.2	3.1	5.1	4.8	1.3	2.0	3.6	1.9	1.0	1.4
26	15.8	5.2	10.6	3.7	3.6	3.4	5.8	5.3	1.2	1.9	3.9	2.3	1.1	1.4
27	18.2	6.1	12.1	4.3	4.1	4.3	6.3	5.7	1.6	2.3	4.4	2.2	1.1	1.6
28	19.0	6.2	12.8	4.5	4.3	4.3	6.8	6.1	1.4	2.5	4.7	2.5	1.1	1.6
28	19.6	6.8	12.8	4.7	5.0	5.0	6.8	6.6	1.7	2.4	4.8	2.5	1.2	1.6
29	19.8	6.4	13.4	4.6	4.8	4.7	7.4	6.5	1.6	2.3	4.7	2.7	1.2	1.6
34	21.5	7.2	14.3	5.0	5.2	5.1	8.0	6.9	1.9	2.3	5.0	2.8	1.2	1.9
35	21.6	7.4	14.2	5.1	5.1	5.0	7.9	7.2	2.0	2.3	5.1	3.0	1.3	1.7
36	22.3	7.4	14.9	5.2	5.5	5.2	8.2	7.2	2.0	2.6	5.3	3.0	1.2	2.1
37	24.0	8.0	16.0	5.4	5.7	5.9	8.5	7.2	2.2	3.0	5.5	3.1	1.3	2.0
Microhyla pulchella sp. nov. ($N = 6$)														
28	20.2	8.2	12.0	6.3	5.1	5.1	9.6	8.4	1.9	3.0	6.1	2.8	1.0	2.5
29	21.6	8.4	13.2	6.5	5.2	5.2	9.7	8.7	2.0	3.0	6.4	3.0	1.1	2.4
31	21.5	8.3	13.2	6.6	5.3	5.1	9.4	9.0	1.9	2.8	6.6	3.0	1.0	2.8
35	23.3	9.0	14.3	7.0	5.5	5.5	10.8	10.1	2.1	2.9	6.8	3.3	1.2	3.0
36	21.7	8.3	13.4	6.7	5.2	5.3	10.0	9.1	1.8	2.8	6.7	3.0	1.1	2.8
37	21.8	8.2	13.6	6.0	5.2	5.1	9.3	8.7	2.0	3.0	6.2	3.0	1.1	2.9
Microhyla minuta sp. nov. ($N = 5$)														
26	6.6	2.1	4.5	1.3	0.9	1.0	2.3	2.0	0.5	0.7	1.5	0.8	0.4	0.5
35	14.3	4.2	10.1	2.6	2.1	2.1	4.8	3.5	0.8	1.2	2.5	1.5	0.7	0.8
35	15.1	4.9	10.2	2.6	2.3	2.3	5.5	4.6	0.9	1.1	2.6	1.8	0.7	0.9
36	14.5	4.8	9.7	2.7	2.1	2.3	5.5	4.5	0.8	1.1	2.6	2.0	0.7	0.9
36	15.5	4.9	10.7	2.8	2.3	2.3	5.4	4.5	0.9	1.1	2.6	1.9	0.7	1.0

Abbreviations: TL, total length; BL, body length; TaL, tail length; BW, body width; BH, body height; TH, tail height (maximal); SVL, snout-vent length; SSp, snout-spiraculum length; UF, upper fin height (maximal); LF, lower fin height (maximal); IP, interpupilar distance; PR, pupillo-rostral distance; ED, eye diameter; ODW, oral disk width.

Rowley, Le, Thi, Stuart et Hoang, 2010, *Theloderma palliatum* Rowley, Le, Hoang, Dau et Cao, 2011, *Leptobrachium leucops* Stuart, Rowley, Tran, Le et Hoang, 2011, and *Leptobrachium pullum* (Smith, 1921). Breeding activity of *M. annamensis* was recorded at the same sites with *R. annamensis*, *O.* cf. *hansi*, *Feihyla palpebralis* (Smith, 1924) and *Microhyla pulchella* sp. nov.

Distribution. The currently known distribution of *M. annamensis* is shown in Fig. 1. After the revision of Bain and Nguyen (2004) and the description of *M. marmorata* and *M. pulverata*, regarded as *M. annamensis* by previous authors (Inger et al., 1999, Stuart, 1999, Ziegler, 2002), Laos and central Vietnam were excluded from the distribution range of this species. The type locality of *M. annamensis* is "Sui Kat" on Langbian Plateau. We recorded this species in several localities of the Langbian Plateau and surrounding mountain systems at a wide range of elevations from ~1000 to 2000 m a.s.l. Currently (Fig. 1) *M. annamensis* is recorded at several localities in Bidoup – Nui Ba National Park (Giang Ly station, the environs of Bidoup and Hon Giao Mts.) in Lam Dong Province, near Sui Kat, Hon Ba Mt. and the eastern slopes of Hon Giao Mt. in Khanh Hoa Province, the environs of Chu Pan Phan Mt. in Chu Yang Sin National Park, Dak

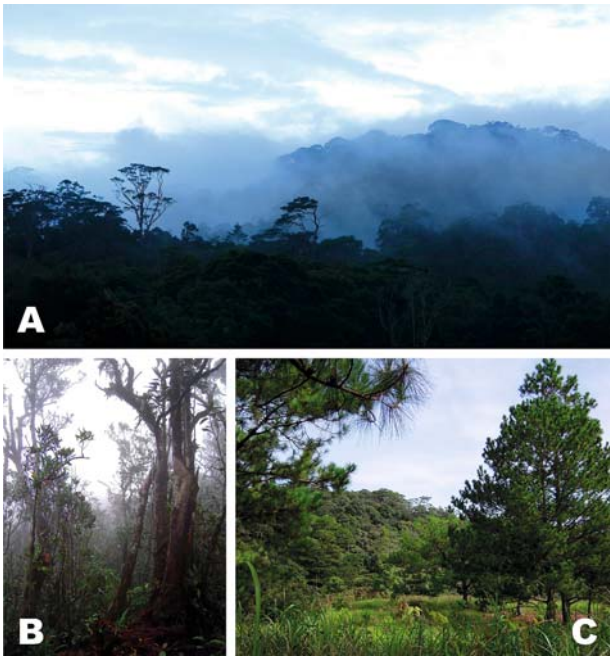

Fig. 7. Natural habitat of *Microhyla* species in Bidoup – Nui Ba National Park, Lam Dong Province: (A) mixed evergreen montane forest, environs of Giang Ly station, natural habitat of *M. annamensis*, *M. berdmorei*, *Microhyla pineticola* sp. nov., *Microhyla pulchella* sp. nov.; (B) evergreen elfin cloud forest on the slopes of Hon Giao Mt., natural habitat of *Microhyla pulchella* sp. nov.; (C) dry pine forest on the slopes of Bidoup Mt., natural habitat of *Microhyla pineticola* sp. nov. Photos by O. V. Morozova.

Lak Province. A discovery of this species in the northern part of Ninh Thuan Province is highly anticipated, though it seems unlikely that the distribution of *M. annamensis* extends any further beyond the Langbian Plateau. However, Bain and Nguyen (2004), referring to previously published data, indicate that the species might be found in Ha Tinh Province, Vietnam (Semenov, 2001), at the Cardamom Mountains in Cambodia (Ohler et al., 2002) and on Khao Sebab Mt., Thailand (Taylor, 1962). Such a disjunct distribution of specialist highland species like *M. annamensis* seems to be unlikely; we suggest that the status of Cambodian and Thai populations should be reconsidered after careful examination and comparison to *M. annamensis*.

***Microhyla pineticola* sp. nov.**
Figs. 8 – 13

Synonymy. *Microhyla* sp. 1 — Poyarkov [Paiarkov] and Vassilieva, 2011: pp. 175, 203; Fig. 5.8.

Holotype. ZMMU A-5043 (field number NAP-01032), adult female from Mt. Bidoup, Bidoup – Nui Ba National Park, Da Nhim River valley, Da Chais Commune, Lac Duong District, Lam Dong Province, Vietnam (coordinates 12°9′57.24″ N 108°39′44.28″ E, elevation 1800 m a.s.l.), collected by N. A. Poyarkov on 01 May 2009.

Paratypes. ZMMU A-[redacted] (field numbers NAP-01033, NAP-01150 – 01155, NAP-01158 – 01160, 2 sp. no field labels) 6 adults males and 3 adult females from the environs of Giang Ly ranger station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam (12°11′7.8″ N 108°41′21.84″ E, 1480 m a.s.l.) collected by N. A. Poyarkov on 05 May 2009; ZMMU A-4813 (field number NAP-01033), an adult female from the type locality (same collection data as for the holotype); ZMMU A-4333 (field numbers NAP-00106, NAP-00522), 2 adult males from the environs of Long Lanh, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam (12°9′6.48″ N 108°39′10.44″ E, 1507 m a.s.l.) collected by N. A. Poyarkov on 04 May 2009; ZMMU A-4331 (field numbers NAP-00552, NAP-00553, NAP-01316, NAP-01422) 2 adult males and 2 adult females from Da Nhim river valley, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam (12°10′17.4″ N 108°40′45.84″ E, 1470 m a.s.l.) collected by N. A. Poyarkov and A. B. Vassilieva on 26 June 2010); ZMMU A-5080 (field numbers NAP-01750, NAP-01800, NAP-01883 – 01885) 4 adult males, an adult female from the same locality as ZMMU A-4812 collected by N. A. Poyarkov, A. B. Vassilieva and E. A. Galoyan on 07 July 2011; ZMMU A-5043 (field number NAP-01170), an adult male from Mt. Bidoup, Bidoup – Nui Ba National Park, Da Nhim River valley, Da Chais Commune, Lac Duong District, Lam Dong Province, Vietnam (12°6′57.24″ N 108°39′44.28″ E, 1800 m a.s.l.), collected by N. A. Poyarkov on 01 May 2009; ZISP 11816 (field number A), a juvenile, locality same as the holotype, collected by N. L. Orlov on 26 – 29 April 2004; ZISP 11819, an adult male from the environs of Giang Ly ranger station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam (12°11′7.8″ N 108°41′21.84″ E, 1480 m a.s.l.) collected by N. A. Poyarkov on 05 May 2009; UNS 5093 and UNS 5095 (field numbers DT0188, DT0191), adult males, UNS 5094 and ZFMK 95625 (field numbers DT0189, DT0190, DT0189), adult female from Bidoup — Nui Ba National Park, Lam Dong Province, Vietnam (12°12′45.36″ N 108°41′45.96″ E, 1387 m a.s.l.), collected by Tran, T. A. D. on 26 March 2010; UNS 5096 and ZFMK 95626 (field numbers DT0188, DT0237), adult males, from Bidoup — Nui Ba National Park, Lam Dong Province, Vietnam (12°12′46.08″ N 108°41′57.84″ E, 1399 m a.s.l.), collected by Tran, T. A. D. on 28 March 2010; ZFMK 95627 and UNS 5097

(field numbers DT0515, DT0516), adult males, from Bidoup — Nui Ba National Park, Lam Dong Province, Vietnam (12°10′24.96″ N 108°41′55.32″ E, 1504 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 24 June 2011; UNS 5101 (field number DT0802), adult female, from Chu Yang Sin National Park, Krong Bong District, Dak Lak Province, Vietnam (12°25′2.28″ N 108°22′31.8″ E, 1133 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 30 May 2011; UNS 5100 and ZFMK 95629 (field numbers DT0578, DT0579), adult males, from Chu Yang Sin National Park, Krong Bong District, Dak Lak Province, Vietnam (12°25′25.32″ N 108°21′1.08″ E, 864 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 01 June 2011; UNS 5098, UNS 5099, and ZFMK 95628 (field numbers DT0529, DT0556, DT0557), adult males, from Chu Yang Sin National Park, Krong Bong District, Dak Lak Province, Vietnam (12°27′4.32″ N 108°27′16.92″ E, 880 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 04 – 05 June 2011..

Referred materials. Series of tadpoles ZMMU A-5044 (field number NAP-02476; stages 25 – 37; 13 specimens; description based on 16 specimens, stages 26 – 28, some specimens were destroyed during preparation), collected in a small still temporary pond near the road Da Lat – Nha Trang, environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam (coordinates 12°11′7.8″ N 108°41′21.84″ E, elevation 1480 m a.s.l.) by A. B. Vassilieva, N. A. Poyarkov and E. A. Galoyan on 11 July 2011. Larvae were allocated to *Microhyla pineticola* sp. nov. by COI DNA-barcoding following the standard protocols (see Smith et al., 2008, Che et al., 2012, Murphy et al., 2013).

Diagnosis. *Microhyla pineticola* sp. nov. is characterized by a combination of the following characters: 1) a medium-sized species of *Microhyla*, body stocky; 2) SVL of adult males 17.2 – 19.5 mm, mean 18.3 mm; SVL of adult females 18.0 – 23.0 mm, mean 19.4 mm; 3) dorsum smooth, sometimes feebly shagreened on flanks; 4) head triangular, snout acuminate in profile; 5) finger I short, less than one-half the length of finger II; 6) tips of three outer fingers weakly dilated, forming weak disks, dorsally with a median longitudinal groove; 7) tips of all toes distinctly dilated into disks, dorsally with a weak median longitudinal groove producing the appearance of two scutes; expanded toe disks less than twice the width of phalanges; 8) outer metacarpal tubercle single, round; inner metacarpal tubercle oval and prominent; 9) tibiotarsal articulation at straightened limb reaching beyond eye but not reaching snout tip; 10) webbing basal: one and a half of phalanx at toe I, two and a half phalanges on preaxial side of toe II, and less than two phalanges on postaxial side of toe II, three phalanges on preaxial side of toe III, less than three phalanges on postaxial side of toe III, less than four phalanges on preaxial side of toe IV, four phalanges on postaxial side of toe IV and two and a half phalanges at toe V are free of webbing; inner and outer metatarsal tubercles present, inner short, rounded and prominent, outer short, rounded and often barely distinct; 11) upper eyelid without supraciliary spines; 12) canthus rostralis with dark lines, top of snout well-differentiated in color from the brown interorbital bar, which bears a dark spot; dark stripe along the supratympanic fold continuing into interrupted dark dorsolateral stripes; narrow creamy white stripe extending from rear corner of eye to axilla; 13) light thin vertebral stripe present; 14) small dark rounded spot at middorsum, divided by a light vertebral stripe; dorsal markings formed by dark brownish lines parallel to vertebral and dorsolateral stripes, usually narrowly outlined in beige, forming a pattern resembling a grain of pinewood; 15) a narrow, broken, black lateral stripe from above arm almost reaching groin, clearly separating darker flanks and lighter dorsum; 16) chin light grayish with a thin light medial stripe, belly whitish with indistinct grayish mottling; 17) larvae with oral disk which forms a dorsally oriented funnel, upper labium thickened, oral flaps form prominent rounded lobes in each mouth corner, lower labium forming umbelliform disk bordered with semicircular marginal ridges; tail long, approximately twice the body length, with moderately developed muscular part and thin terminal portion.

Measurements of holotype (in mm). SVL 22.3; HL 7.3; SL 2.8; EL 2.4; N-EL 1.8; HW 7.0; IND 2.2; IOD 2.5; UEW 1.6; FLL 12.1; LAL 8.7; HAL 5.4; 1FL 1.3; IPTL 0.8; OPTL 1.0; 3FDD 0.8; HLL 35.6; TL 12.7; FL 12.9; IMTL 0.9; 1TOEL 2.2; OMTL 0.8; 3TDD 1.1.

Description of holotype. Medium-sized specimen, SVL 22.3 (all measurements in mm); habitus stocky, body triangular shaped (Fig. 8); head triangular, longer (7.3) than wide (7.0); snout long (2.8), abruptly rounded in dorsal view (Fig. 8A) and acuminate in profile, projecting beyond margin of lower jaw (Fig. 8B); eyes comparatively small, slightly protuberant, much shorter (2.4) than snout (3.2) (EL/SL 0.85) and interoribtal distance (2.5). Top of head flat, canthus rostralis rounded, sharp; loreal region steep, weakly concave; nostril round, lateral, below canthus rostralis, closer to tip of snout (1.4) than to eye (1.8), interorbital distance (2.5) greater than internarial distance (2.2), upper eyelid much narrower (1.6) than interorbital distance (2.5). Pineal spot absent; tympanum hidden; weak supratympanic fold present, runs straight from posterior corner of eye to tympanal area, curving smoothly at distance over 1.5 of eye diameter, and running straight to arm insertion. Choanae elongated and oval-shaped, widely spaced; upper jaw

edentate; vomerine teeth absent, tongue without papillae, roundly spatulate and free behind for 0.4 times of its length.

Forelimbs short (12.1) and slender; lower arm long and thin (8.7), hand (5.4) over two times shorter than forelimb length (HAL/FLL 0.44). Fingers slender, free of webbing, rounded in cross-section, no skin fringes on fingers present; first finger well-developed (Fig. 9A), little less than one-half the length of the second finger, second finger slightly shorter than fourth, latter much longer than first (1.3); relative finger lengths: I < II < IV < III; tips of three outer fingers notably dilated and forming weak round disks almost equal in width or slightly wider than basal phalanges, diameter of first finger at the basis (0.3) more than one-third that of third finger disk (0.8); all disks bearing narrow peripheral grooves, dorsally finger tips with median longitudinal grooves producing the appearance of two scutes, grooves present in fingers II, III, IV; relative finger disk widths: I < IV ≤ II ≤ III; subarticular tubercles on fingers distinct, rounded and prominent, formula 1, 1, 2, 2; nuptial pad absent (Fig. 9A); inner metacarpal tubercle oval, elongated and prominent; a single outer metacarpal tubercle (1.0) flat and rounded, larger than the inner metacarpal tubercle (0.8).

Hindlimbs slender and long (35.6), about three times longer than forelimbs (HLL/FLL 2.9); tibia long (12.7), over one-third of hindlimb length, heels largely overlapping when thighs are held at right angles to body; tibiotarsal articulation of adpressed limb reaching beyond the level of nostril but not projecting beyond the snout tip; foot (12.9) slightly longer than tibia. Relative toe lengths: I < II < V < III < IV; tarsus smooth, inner tarsal fold absent; tips of all toes distinctly dilated into disks, slightly wider than those of fingers (disk diameter of third toe 1.1; 3FDD/3TDD 0.72), dorsally all toes with median longitudinal grooves at disks; relative toe disk widths: I < V ≤ II < III = IV; webbing between toes basal and poorly developed (Fig. 9B), webs present between second and third toe reaching the level of first subarticular tubercles, webbing formula (the number of phalanges free of web): I 1½ – 2½ II 1¾ – 3 III 2¾ – 3¾ IV 4 – 2½ V; subarticular tubercles on toes similar to those on fingers but smaller, prominent, rounded, formula 1, 1, 2, 3, 2; inner metatarsal tubercle elongated, oval, large and prominent, length (0.9) is slightly less than half of first toe (2.2); outer metatarsal tubercle rounded, elevated and very well distinct, slightly smaller (0.8) than length of inner metatarsal tubercle.

Dorsal skin almost smooth above (Fig. 8A), with few tiny tubercles scattered in posterior part of dorsum and along the dorsolateral edges; dorsolateral edges sharp, oblique to groin, more flat posteriorly; upper eyelid without supraciliary spines; flanks of body and lateral sides of head smooth, hindlimb dorsally scattered with few low pustules; ventral side of body and limbs smooth (Fig. 8B), vent area smooth with few low tubercles in cloacal region. Cloacal opening unmodified, directed posteriorly, at lower level of thighs.

Coloration in life. Color in life pinkish brown dorsally, with a distinct darker pattern (Fig. 8A). A distinct brown interorbital bar in shape of a reverse triangle runs transversally across the head between the most medial parts of upper eyelids, not covering the posterior half of eyelid. A dark mark runs posteriorly from interorbital bar, narrows gradually at head basis and continues towards sacrum forming a brownish 1 – 2 mm wide dorsomedial band with irregular borders edged with dark brown. The dark dorsomedial band at the point ~3 mm anteriorly to cloacal opening bifurcates in two narrower dark stripes running obliquely from sacrum towards groin area forming an inverse Y-pattern. Narrow dark-brown irregular bands are running parallel to the dorsomedial dark band from head basis towards groin area: bands have irregular borders and are edged with beige or light-brown, three rows of such bands are running on left and right sides of body from the dark dorsomedial band, they are straight and slightly diverge from each other towards groin area, forming a pattern clearly resembling polished grain of pine-wood (Fig. 8A). A pair of indistinct dark-brown ocelli is present at head basis between orbits on the interorbital bar (similar to those seen in Figs. 10A and 11A). A distinct round black spot edged with dark brown is present on dorsomedial line posterior to the scapular area, approximately at the point of one half of SVL (Fig. 8A). Two smaller black spots are present at head basis on the dorsomedial line and in the groin area on the left side of body. A thin but distinct continuous light-beige vertebral stripe runs from snout tip along the dorsomedial line straight towards a point above cloacal opening, dividing the dark dorsomedial band and the black dorsal spot in two equal parts. A distinct small round white supraciliary spot is present on the periphery of upper eyelid on both sides of body, with the spots located in the posterior part of upper eyelids.

Flanks of body and head darker than the dorsum, a dark lateral stripe lasts from snout tip to nostril, gently curving along the edge of canthus rostralis towards the anterior corner of eye, and goes further posteriorly, running from the posterior edge of eye along the supratympanic fold, sharply curving ventrally straight above the insertion of forelimb, forming a triangular black spot in the tympanal area. Above the axilla a paler brownish spot, posterior to it a discontinuous dark lateral stripe runs further backwards along dorsolateral edges slightly

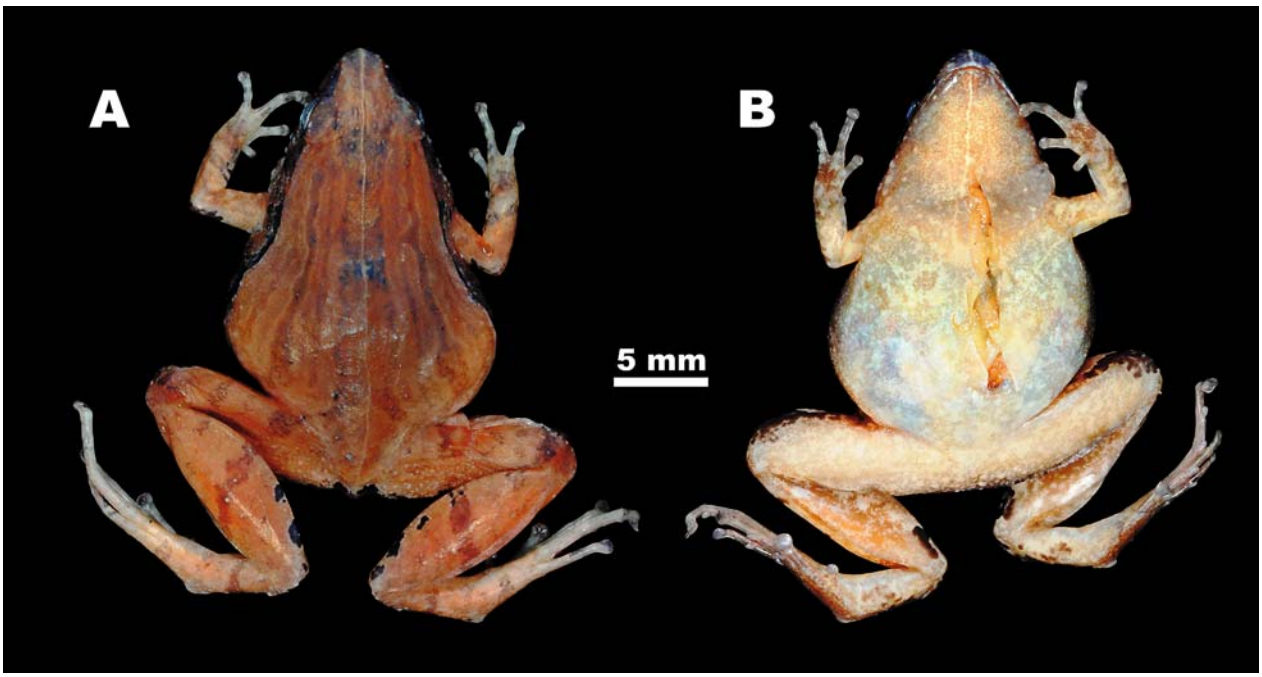

Fig. 8. Holotype of *Microhyla pineticola* sp. nov. (ZMMU A-5043, adult female) in preservative: (A) dorsal view; (B) ventral view. Photos by N. A. Poyarkov.

curving ventrally towards groin area. Dark coloration of lateral stripes gradually turns paler ventrally, lateral stripes edged with a series of elongated black spots of irregular shape dorsally, which disappear posteriorly at the groin area. Upper jaw brownish with numerous small white spots below the eye level and a small oval-shaped dark-brown spot in the center of maxilla (similar to that in Fig. 11A). A cream stripe extending from posterior corner of eye to axilla. Except for the upper arms, limbs dorsally with narrow indistinct dark brown cross-bars: three bars on both lower arms, three bars on each thigh and shank. Characteristic black spot on upper arm in the elbow area, and on anterior surface of thigh extending to the knee area; double black spots on posterior edges of shanks. Fingers and toes dorsally with dark traverse bars.

Ventral surfaces colored light; belly cream-white, with indistinct light-brown and beige marbling in central parts of belly (Fig. 8B); chin covered with dense grayish spotting, notably darker along margins of lower jaw and mouth angles; a thin white medial line running from chin to chest. Limbs ventrally with irregular grayish spotting; at ventral surfaces of hand (Fig. 9A) and foot (Fig. 9B) distinct dark-brown or blackish markings, which continue to ventral surfaces of fingers and toes. Iris bronze with black reticulation, darkly pigmented at anterior and posterior corners; pupil round, black, outlined with a golden circle.

Coloration in preservative. In preservative colors have slightly faded (Fig. 8), especially reddish and pinkish tints; yellowish coloration of ventral sides turn cream.

Variation and sexual dimorphism. Individuals of the type series are generally similar in appearance. Variation in size and body proportions is given in Table 1. Females are larger than males: SVL 17.2 – 19.5 mm in males ($N = 14$) (Figs. 10, 11B), 18.0 – 23.0 mm in females ($N = 9$) (Fig. 11A); slit-like openings of a median subgular vocal sac are present in males. Male paratypes generally show a slightly different coloration pattern (see Figs. 10, 11B): color of head and dorsum yellowish brown; dorsum with an irregular brown pattern, edged in dark brown or beige, always with a thin white stripe along the midline; a large dark brown spot in the middle of dorsum, two black spots on shoulders may be absent (Fig. 10A) or present (Fig. 11B), and some small spots on posterior part (Fig. 10A); a large, butterfly-shape, dark brown mark on dorsum usually present (Figs. 10, 11B) while usually absent in females (Fig. 11A); lateral head light brown (Fig. 10) or dark brown with light spotting (Fig. 11); a dark brown stripe, from tip of snout, through eye, enlarged to a triangular patch in the temporal region; flank brown with a thick, dark brown dorsolateral stripe may be continuous (Figs. 10A, 11A) or discontinuous, interrupted at axilla level (Fig. 11B); chin and throat brown; a thin line running from chin to chest; belly

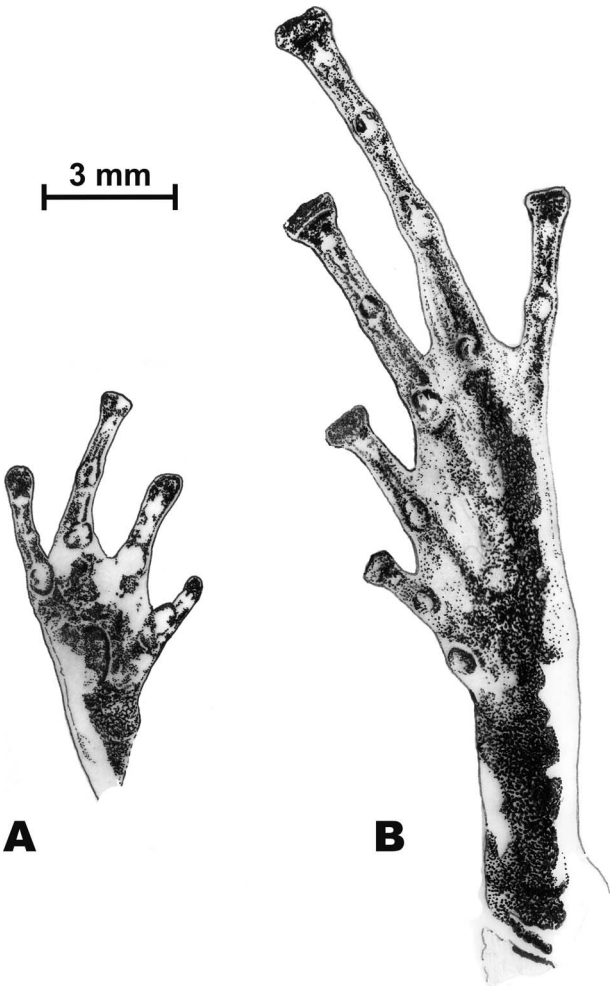

Fig. 9. Holotype of *Microhyla pineticola* sp. nov. (ZMMU A-5043, adult female): (A) palmar view of the right hand; (B) plantar view of the left foot. Drawings by V. D. Kretova.

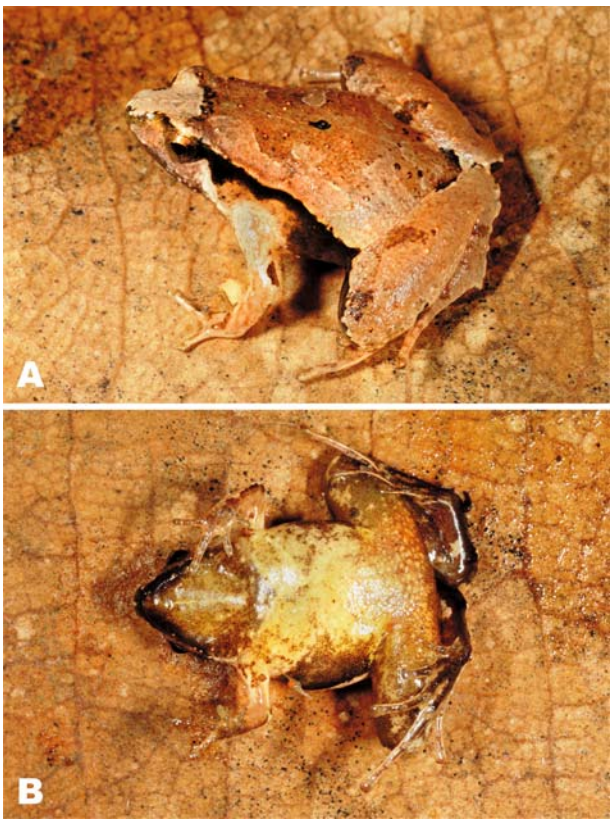

Fig. 10. Paratype of *Microhyla pineticola* sp. nov. (ZMMU A-5043, adult male from environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam) in life: (A) dorsolateral view; (B) ventral view. Photos by N. A. Poyarkov.

bright, yellowish white, usually with brown marbling; throat and chest are darkly pigmented, and abdomen brightly yellowish (Fig. 10B). Cross-bars on limbs indistinct (Fig. 10A), or distinct (Fig. 11); few dark brown patches present on dorsal surfaces of body, forearm and tibia; ventral thigh yellowish brown; anterior and posterior thigh dark brown; iris bronze or golden; pupil round, black outlined with a bronze circle.

Tadpole description.

General morphology. Tadpole external morphology is shown in Fig. 12 and 13. Variation in size and body proportions of tadpoles is given in Table 2.

In dorsal view (Figs. 12A and 13A), body elliptical or almost pyriform, with head part larger than belly (maximum width at eyes level); snout rounded. From lateral view (Figs. 12B, 13B), body almost triangular, flattened above and rounded below. Tail long, approximately twice as long as body (TaL/BL 1.9 – 2.1), with a moderately developed muscular part and a thin terminal filament. Muscular portion at tail base nearly equal in height to the lower fin. Upper fin not extending on the trunk and reaching its maximum height in the second third of the tail; lower fin highest in the proximal third of the tail, with maximal height greater than that of the upper fin. Spiracle medial, free portion forming an elongate, relatively narrow membrane with even edges ending near the caudal end of belly (see Fig. 13C). Vent tube almost vertical, opening medially in the beginning of the lower tail fin.

Eyes lateral, bulging, relatively big (eye diameter about 0.18 the body length, ED/BL = 0.16 – 0.21); pupils oriented laterally and slightly ventrally, visible from below. Oral disk forming a dorsally oriented funnel (see Figs. 12 and 13D); upper labium thickened, oral flaps forming prominent rounded lobes in each mouth corner; lower labium with umbelliform disk bordered with semicircular marginal ridges; enlarged Ω-shaped

Fig. 11. Paratypes of *Microhyla pineticola* sp. nov. in life: (A) adult female from Mt. Bidoup, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam, dorsolateral view (ZMMU A-5043, field number NAP-01170); (B) adult male from environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam, dorsal view. Photos by N. A. Poyarkov.

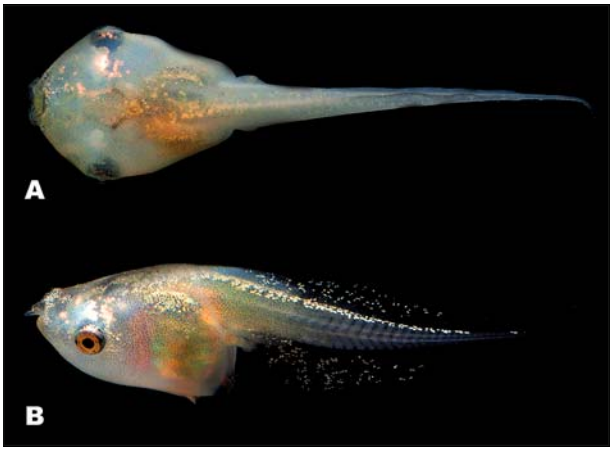

Fig. 12. Tadpoles of *Microhyla pineticola* sp. nov. (Stage 35 – 36) in life: (A) lateral view; (B) dorsal view. Photos by E. A. Galoyan.

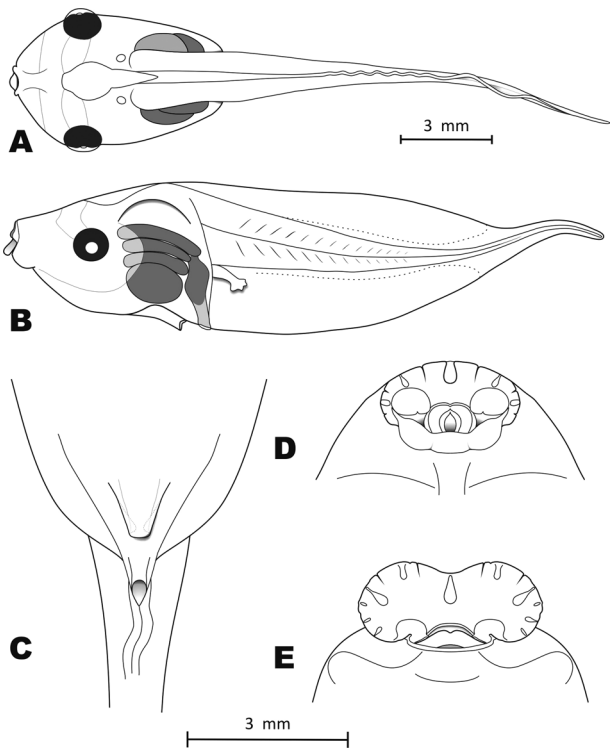

Fig. 13. External morphology of *Microhyla pineticola* sp. nov. tadpole (Stage 35): (A) dorsal view; (B) lateral view; (C) vent area; (D) mouth area (dorsal view); (E) mouth area of *Microhyla heymonsi*. Drawings by A. B. Vassilieva.

infralabial flange bearing several prominent papillae. Keratinized elements (denticles, beak) absent. Nostrils not opened at stages available (26 – 37). Lateral line system not discernible.

Coloration in life. Dorsal surface of body and tail dark gray, with two silver shining elongated transversal patches between eyes (Fig. 12); the pigmented dorsal coelomic lining forming two short dark stripes along the tail muscles extending on the trunk; lateral and ventral body walls semitransparent, with few scattered chromatophores in the skin; gills and intestinal loops well visible. Tail fins grayish, semitransparent, with a thin unpigmented terminal portion.

Natural history notes. In Bidoup – Nui Ba National Park the new species was observed (see Poyarkov and Vassilieva, 2011) in the mixed montane polydominant tropical forests with the predominance of *Pinus* (= *Du-campopinus*) *krempfii* (Pinaceae) and Fagaceae (*Lithocarpus*, *Castanopsis*, *Quercus*) with a understory of *Pandanus* sp. (Pandanaceae) at elevations of ~1500 m a.s.l., and in the dry monodominant pine forest formed mostly by *Pinus kesiya* (Pinaceae), with a developed herb layer

formed by ferns *Dicranopteris* sp. (Gleicheniaceae) and *Woodwardia* sp. (Blechnaceae), and grasses (Poaceae), at elevations 1500 – 1800 m a.s.l. (Kuznetsov et al., 2006). All frogs were found on ground, during day or night.

Breeding. Breeding was not observed. Tadpoles of advanced stages were found during the rainy season in mid-July in a small ephemeral pool near the road Nha Trang – Da Lat on the edge of a *Pinus* (*Ducampopinus*) *krempfii* forest at elevation 1480 m a.s.l. Tadpoles were swimming near the water surface during the day, forming dense groups numbering several tens of individuals.

Syntopic batrachofauna. In mixed forests of Bidoup – Nui Ba National Park the new species co-occurs with *I. galeatus*, *R. vampyrus*, and *M. annamensis*; tadpoles were found in a pond close to the breeding sites of *F. palpebralis* and *Polypedates megacephalus* Hallowell, 1861.

Comparisons. The new species *Microhyla pineticola* sp. nov. is compared here with all known congeners. All major diagnostic characters and their states as well as distribution data for all recognized species of the genus *Microhyla* are summarized in Table 3.

A suite of characters differentiates *Microhyla pineticola* sp. nov. from all of its Indochinese and East Asian congeners (see Table 3). The presence of basal rudimentary webbing, present only between toe II and toe II reaching the level of first subarticular tubercles in *Microhyla pineticola* sp. nov. clearly differs this taxon from *Microhyla* species with full foot webbing reaching disks or well-developed foot webbing reaching to disks as a fringe: in *M. annamensis* (see Fig. 3), *M. berdmorei* (see Fig. 2A, B), *M. marmorata* (see Fig. 2H), *M. nanapollexa* and *M. pulverata*; the new species is further differentiated from the sympatric species *M. berdmorei* by a smaller body size (SVL 17.2 – 23.0 in *Microhyla pineticola* sp. nov. vs. 23.8 – 45.6 in *M. berdmorei*) and from the sympatric species *M. annamensis* (see Fig. 3) by its smooth dorsal skin (vs. warty, strongly tubercular dorsal skin in *M. annamensis*).

The presence of notably developed disks on three outer fingers and all toes in *Microhyla pineticola* sp. nov. clearly differs the new species from *Microhyla* species which lack disks on fingers and toes: *M. fissipes* (see Fig. 2C), *M. okinavensis* Stejneger, 1901, *M. pulchra* (see Fig. 2G), *M. picta* (see Fig. 2H). The latter two species are further separated from *Microhyla pineticola* sp. nov. by their stout body habitus in *M. picta* (vs. stocky body habitus in *Microhyla pineticola* sp. nov.), their larger size (SVL 17.2 – 23.0 in *Microhyla pineticola* sp. nov. vs. 25.2 – 33.4 in *M. picta* and 23.0 – 36.5 in *M. pulchra*), a shovel-shaped metatarsal tubercle in *M. picta* (vs. small rounded tubercle in the new species) and different dorsal coloration pattern (see Fig. 2F, G). The species is also clearly separated from *M. mixtura* Liu et Hu, 1966 by its stocky body habitus (vs. stout habitus in *M. mixtura*), well-developed disks on fingers with dorsal median grooves (vs. poorly developed finger disks with no dorsal median grooves discernible in *M. mixtura*) and snout acuminate in profile (vs. snout rounded in profile in *M. mixtura*).

The new species is differentiated from the Southeast Asian species *M. butleri* by a following combination of characters: stout body habitus with snout acuminate in profile (vs. slender body habitus with short snout, clearly rounded in profile in *M. butleri*), smooth dorsal skin (vs. reddish tubercles present in *M. butleri*, see Fig. 2C), somewhat reduced first finger, which is less than half of second finger (vs. well developed first finger, longer than half of second finger in *M. butleri*) and its dorsal coloration pattern with a characteristic light vertebral stripe and round black spot in the center of dorsum (vs. no vertebral stripe and black spot present in *M. butleri*, see Fig. 2C).

Among all other species of Indochinese *Microhyla* the new species is undoubtedly most similar to *M. heymonsi* (Fig. 2E) and *M. fusca* and assumingly is a member of one complex with these taxa. However, *Microhyla pineticola* sp. nov. can be differentiated from *M. heymonsi* by a suite of morphological characters: by having its tongue deeply free at rear part for more than one-third of its length (vs. tongue free about one-fourth of its length in *M. heymonsi*); hand with two low palmar tubercles and lacking any supernumerary tubercles (vs. three distinct prominent palmar tubercles and supernumerary tubercles usually present on hand in *M. heymonsi*, see Taylor, 1962, Matsui et al., 2013, own data); snout clearly acuminate in profile (vs. snout round in profile in *M. heymonsi*). *Microhyla pineticola* sp. nov. can be further separated from *M. heymonsi* by comparatively much longer hindlimbs: in HLL/SVL rate varies 1.81 – 1.95 in males ($N = 14$) and 1.80 – 2.01 in females ($N = 9$), tibiotarsal articulation of adpressed limb reaching snout, usually protruding beyond margin of snout (vs. HLL/SVL rate varies 1.52 – 1.66, $N = 20$, differences significant ($p < 0.05$); tibiotarsal articulation of adpressed limb usually not protruding beyond margin of snout in *M. heymonsi*). *Microhyla pineticola* sp. nov. also can be separated from Vietnamese populations of *M. heymonsi* by a somewhat more developed foot webbing (webbing formula for *Microhyla pineticola* sp. nov.: I 1½ – 2½ II 1¾ – 3 III 2¾ – 3¾ IV 4 – 2½ V vs. webbing formula for *M. heymonsi*: I 2 – 2½ II 2 – 3 III 3 – 4 IV $4^1/_3$ – 3 V). Finally, *Microhyla pineticola* sp. nov. can be easily differentiated from Vietnamese populations of *M. heymonsi* by its dorsal coloration pattern, the new species shows characteristic dorsal pattern with a thin light vertebral stripe, presence

TABLE 3. Main Diagnostic Characters of Adult Frogs of the Genus *Microhyla* Tschudi, 1838 (based on Bain and Nguyen, 2004; modified and expanded)

Species	SVL, mm		Habit	Snout profile	Dorsum skin
	♂♂	♀♀			
M. achatina	16.0	23.0	Slender	Obtusely pointed	Smooth or feebly tubercular
M. annamensis	15.2 – 19.8	18.2 – 22.6	Moderately stocky	Bluntly rounded	Warty, strongly tubercular
M. annectens	14.4 – 15.6	18.2 – 18.4	Slender	Rounded	Smooth
M. berdmorei	23.8 – 28.9	26.2 – 45.6	Slender	Obtusely pointed	Smooth, small tubercles
M. borneensis	10.6 – 12.8	17.9 – 18.8	Stocky	Obtusely pointed	Smooth, small tubercles
M. butleri	20.0 – 25.0	21.0 – 26.0	Slender	Rounded	Smooth or tubercular
M. chakrapanii	22.0	?	Moderately stout	Obtusely rounded	Smooth
M. fissipes	18.0 – 27.5	20.0 – 28.0	Moderately slender	Rounded	Smooth or slightly tubercular
M. fowleri	29.5 – 32.5	32.2 – 41.5	Stocky	Obtusely pointed	Rugose, pustular
M. fusca	23.0**		Slender	Acuminate	Shagreened, faint middorsal ridge
M. heymonsi	16.5 – 22.0	18.0 – 26.5	Stocky	Rounded	Smooth
M. karunaratnei	15.8 – 19.1	19.6 – 21.0	Moderately stocky	Rounded	Smooth
M. maculifera	12.0 – 13.3	11.8	Moderately stout	Bluntly rounded	Dorsolateral rows of tubercles
M. malang	18.7 – 22.2	19.0 – 23.4	Stocky	Rounded	Smooth
M. mantheyi	15.0 – 29.2	14.8 – 24.1	Stocky	Pointed	Granular, feebly pustular
M. marmorata	18.8 – 21.5	21.1 – 23.2	Moderately stocky	Bluntly rounded	Smooth, or feebly pustular
M. mixtura	20.5 – 23.7	23.8 – 26.6	Stout	Rounded	Smooth, with tubercles
M. mukhlesuri	16.5 – 21.0	17.3 – 18.4	Moderately slender	Rounded	Smooth
M. mymensinghensis	14.2 – 17.6	15.2 – 21.3	Stocky	Truncated	Smooth
M. nanapollexa	?	16.6	Slender	Rounded	Smooth
M. okinavensis	22.5 – 28.2	26.5 – 30.8	Moderately slender	Rounded	Smooth or slightly tubercular
M. orientalis	15.8 – 17.4	15.8 – 17.4	Moderately slender	Rounded	Smooth or slightly tubercular
M. ornata	13.4 – 24.9	24.9 – 26.2	Moderately slender	Rounded	Smooth or slightly tubercular
M. palmipes	16.0	21.8	Slender	Rounded	Smooth or slightly tubercular
M. perparva	10.5 – 11.9	12.4 – 14.5	Moderate	Obtusely pointed	Smooth
M. petrigena	13.9 – 16.2	15.1 – 17.8	Moderately stout	Obtusely pointed	Smooth, flank and posterior tubercles
M. picta	25.2 – 30.1	27.2 – 33.4	Stout	Rounded	Smooth or slightly warty
M. pulchra	23.0 – 32.0	28.0 – 36.5	Stocky	Obtusely pointed	Smooth, feebly granular
M. pulverata	17.5 – 19.5	18.8 – 20.2	Moderately stocky	Bluntly rounded	Smooth, or feebly pustular
M. rubra	20.0 – 27.5	20.5 – 29.5	Stout	Rounded	Smooth, feebly tuberculated
M. sholigari	?	11.0 – 15.0	Moderately slender	Truncated	Smooth
M. superciliaris	?	12.0	Slender	Rounded	Smooth
M. zeylanica	14.4 – 18.3	15.8 – 20.0	Moderately slender	Rounded	Smooth or slightly tubercular
M. pineticola sp. nov.	17.2 – 19.5	18.0 – 23.0	Stocky	Acuminate	Smooth
M. pulchella sp. nov.	14.7 – 21.6	18.1 – 25.8	Moderately stocky	Bluntly rounded	Smooth
M. minuta sp. nov.	14.7 – 15.9	15.7 – 17.2	Slender	Bluntly rounded	Granular, feebly pustular
M. darevskii sp. nov.	27.0 – 32.6	?	Stocky, flattened	Rounded	Slightly tubercular or pustulate
M. arboricola sp. nov.	13.2 – 15.0	15.9 – 17.0	Moderately slender	Pointed	Feebly granular

Species	F1***	FD	FMG	TD	TMG	MTT	DML	SCT
M. achatina	F1 < ½ F2	+	+	+	+	2	+	–
M. annamensis	F1 < ½ F2	+	+	+	+	2	–	–
M. annectens	F1 < ½ F2	+	+	+	+	1	–	–
M. berdmorei	F1 < ½ F2	+, weak	+	+	+	2	–	–
M. borneensis	nub or bulge	weak or -	+	+	+	2	–	–
M. butleri	F1 > ½ F2	+, weak	+	+	+	2	–	–
M. chakrapanii	F1 > ½ F2	–	–	+	–	2	–	–
M. fissipes	F1 < ½ F2	–	–	–	–	2	–	–
M. fowleri	F1 > ½ F2	weak or –	–	+	+	2	–	–
M. fusca	F1 < ½ F2	+, F3	?	weak, T2 – T5	+, T4	2	–	–
M. heymonsi	F1 ≤ ½ F2	+	Usually +	+	Usually +	2	+	–

TABLE 3 (continued)

Species	F1***	FD	FMG	TD	TMG	MTT	DML	SCT
M. karunaratnei	F1 > ½ F2	+	+	+	+	2	–	–
M. maculifera	F1 > ½ F2	–	–	+, weak	–	1	–	–
M. malang	F1 < ½ F2	+	+	+	+	2	–	–
M. mantheyi	F1 < ½ F2	+	+	+	+	2	–	–
M. marmorata	F1 < ½ F2	+	+	+	+	2	–	–
M. mixtura	F1 < ½ F2	+, weak	–	+	+	2	–	–
M. mukhlesuri	F1 > ½ F2	–	–	–	–	2	–	–
M. mymensinghensis	F1 > ½ F2	–	–	–	–	2	–	–
M. nanapollexa	nub or bulge	+	+	+	+	1	–	–
M. okinavensis	F1 ≤ ½ F2	–	–	–	–	2	–	–
M. orientalis	F1 < ½ F2	weak, F2-F4	+	+	+	2	+	–
M. ornata	F1 ≤ ½ F2	–	–	–	–	2	–	–
M. palmipes	nub or bulge	+	–	+	–	2	–	+
M. perparva	nub or bulge	+	–	+	+	1	–	–
M. petrigena	nub or bulge	+	+, weak	+	+	1	–	–
M. picta	F1 < ½ F2	–	–	–	–	2	–	–
M. pulchra	F1 < ½ F2	–	–	–	–	2	–	–
M. pulverata	F1 < ½ F2	+	+	+	+	2	–	–
M. rubra	F1 ≤ ½ F2	–	–	–	–	2	–	–
M. sholigari	F1 > ½ F2	+	–	+	+	2	+	–
M. superciliaris	F1 < ½ F2	+	–	+	+, weak	2	–	+
M. zeylanica	F1 > ½ F2	–	–	+	–	2	–	–
M. pineticola sp. nov.	F1 < ½ F2	+, F2 – F4	+	+	+, weak	2	+	–
M. pulchella sp. nov.	F1 < ½ F2	+, F2 – F4	+, weak	+	+, weak	1(2)	–	–
M. minuta sp. nov.	F1 ≤ ½ F2	+, F2 – F4	+, weak	+	+	2	–	–
M. darevskii sp. nov.	F1 > ½ F2	–	–	weak	+	2	–	–
M. arboricola sp. nov.	F1 < ½ F2	+, F2 – F4	+, weak	+	+	1	–	–

Species	Tibtars	Foot webbing	Distribution	Source
M. achatina	To snout or just beyond	I 2 – 2½ II 2 – 3¼ III 3 – 4 IV 4 – 3 V	Java, Bali	*, 1, 2
M. annamensis	Well beyond snout	I 1 – 2¼ II 1 – 2½ III 1½ – 2¾ IV 3 – 1 V	Langbian pl. S Vietnam	*, 2
M. annectens	Well beyond snout	I 1 – 1 II 1 – 1 III 1 – 3 IV 3 – 1 V	Malaya, Borneo, Philippines	1, 2, 3
M. berdmorei	Well beyond snout	I 1 – 1 II 1 – 2 III 1 – 2 IV 2 – 1 V	S China, SE Asia to G. Sundas	*, 2
M. borneensis	Shorter than snout	I 1 – 2 II 1 – 3 III 2½ – $3^1/_3$ IV 3½ – 2 V	Sarawak	4, 5
M. butleri	Shorter than snout	I 2 – 2½ II 1¾ – 3 III $2^1/_3$ – 3½ IV 3½ – 2¼ V	S China, SE Asia to Malaya	*, 2
M. chakrapanii	Beyond snout (?)	Basal; between T3 – T4 to proximal tubercle	Andamans	6
M. fissipes	Shorter than snout	I 2 – 2½ II 2 – 3½ III 3 – 4 IV 4 – 3 V	S Thailand, Indochina to Malaya	*, 7
M. fowleri	Well beyond snout	I 1 – 1 II 1 – 1 III 1 – 2 IV 2 – 1 V	N Thailand, S China	2, 8
M. fusca	To the eye	Basal, continue as folds up toes	Langbian pl., S Vietnam	2, 9
M. heymonsi	Shorter than snout	I 2 – 2½ II 2 – 3 III 3 – 4 IV $4^1/_3$ – 3 V	S China, NE India, SE Asia to Sumatra	*, 2, 15
M. karunaratnei	Beyond snout (?)	I 2 – 2½ II 2 – 3½ III 2½ – 3¾ IV 4 – 2 V	S Sri Lanka	10 – 12
M. maculifera	To snout or just beyond	Basal	Sabah, Borneo	2
M. malang	To snout or just beyond	I 1 – 2 II 1 – $2^2/_3$ III $1^2/_3$ – 3 IV 3 – 1 V	Borneo	4, 5
M. mantheyi	Well beyond snout	I 1 – 2 II 1 – 2 III 2 – 3 IV 3 – 1½ V	S Thailand, Malaya	*, 13
M. marmorata	Well beyond snout	I 1 – 2 II 1 – 1¾ III 1½ – 2¾ IV 2¾ – 1 V	C Vietnam, Laos	*, 2
M. mixtura	Shorter than snout	I 2 – 2½ II 1¾ – 3¼ III 3 – 4 IV 4¼ – 2¾ V	C & E China	*, 2, 8
M. mukhlesuri	To snout	I 2 – 2½ II 2 – 3½ III 3 – 4 IV 4 – 2¾ V	Bangladesh	14
M. mymensinghensis	To snout	I 2 – 2½ II 2 – 3½ III 3 – 4 IV 4¼ – 2¾ V	Bangladesh	14
M. nanapollexa	Well beyond snout	I 1 – 2 II 1 – 2½ III 2½ – 2½ IV 2½ – 1 V	Ngoc Linh mt., C Vietnam	2
M. okinavensis	To snout	I 1½ – 2 II 1½ – 3¼ III 2¾ – 4 IV 4 – 2½ V	Okinawa	*, 7
M. orientalis	To the eye	I n.a.– n.a. II 2 – 3¼ III 3 – 4¼ IV 4¼ – 3 V	Bali	15
M. ornata	Shorter than snout	I 2 – 2½ II 1¾ – 3½ III 3 – 4 IV 4 – 2¾ V	Sri Lanka, India to Andamans	*, 7, 11

TABLE 3 (continued)

Species	Tibtars	Foot webbing	Distribution	Source
M. palmipes	To snout or just beyond	I n.a.– n.a. II $2^{1}/_{3}$ – 3¾ III 3¼ – 4 IV 4 – 3 V	Malaya & Sundas	*, 1, 2
M. perparva	Well beyond snout	I 1 – 1 II 1 – 1 III 1 – 2 IV 2 – 1 V	Borneo	2
M. petrigena	Well beyond snout	I 1 – 1 II 1 – 1 III 1 – 2 IV 2 – 1 V	Borneo	2
M. picta	Shorter than eye	I 2 – 2¾ II 1¾ – 2¾ III 2¾ – 3¾ IV 4 – 2½ V	SE Vietnam	*, 2, 16
M. pulchra	To snout or just beyond	I 1½ – 2 II 1 – 3 III 2 – 3¼ IV 3½ – 2 V	S China, Thailand, Indochina	*, 2, 8
M. pulverata	Well beyond snout	I 1 – 2 II 1 – 2½ III 1¾ – 3 IV 3 – 1 V	C Vietnam	*, 2
M. rubra	Shorter than snout	I 1½ – 2 II 1½ – 3 III 2½ – 3 IV 4 – 2½ V	S & E India, Sri Lanka	11
M. sholigari	Shorter than snout	I 1½ – 2 II 2½ – 3½ III 2½ – 3½ IV 3¾ – 2 V	SW India	12
M. superciliaris	To snout or just beyond	I 1 – 1 II 1 – 1 III 1 – 2 IV 2 – 1 V	Malaya, Sumatra	1, 2, 12
M. zeylanica	To the eye	I 2 – 2¼ II 1¾ – 3½ III 2¼ – 3¾ IV 4 – 2 V	C Sri Lanka	11, 12
M. pineticola sp. nov.	Shorter than snout, but beyond the eye level	I 1½ – 2½ II 1¾ – 3 III 2¾ – 3¾ IV 4 – 2½ V	Langbian pl., S Vietnam	*
M. pulchella sp. nov.	Well beyond snout	I 1½ – 2 II 1 – 2 III 1 – 2½ IV 2¼ – 1 V	Langbian pl., S Vietnam	*
M. minuta sp. nov.	Shorter than snout, but beyond the eye level	I n.a.– n.a. II 2 – 3½ III 3 – 4 IV 4 – 3 V	Dong Nai, S Vietnam	*
M. darevskii sp. nov.	Well beyond snout	I 1 – 1 II 1 – 1 III 1 – 1 IV 1 – 1 V	Ngoc Linh mt., C Vietnam	*
M. arboricola sp. nov.	Well beyond snout	I $1^{2}/_{3}$ – 2¼ II 2 – 3 III 2½ – 3½ IV 3 – 1½ V	Langbian pl., S Vietnam	*

Codes and abbreviations for characters: SVL, snout-vent length: reported from the literature as a mean or range, except for *Microhyla fusca*, *M. chakrapanii*, *M. nanapollexa* and *M. superciliaris*, which are known from single specimens; F1, relative length of finger I (I < one-half length of II, I > one-half length of II, present as a nub or pronounced bulge); FD, disks on distal end of fingers (+ present; – absent); FMG, dorsal median longitudinal grooves on finger disks (same); TD, disks on distal end of toes (same); TMG, dorsal median longitudinal grooves on toe disks (same); MTT, number of metatarsal tubercles; DML, presence of absence of light dorsomedial (vertebral) line; SCT, presence or absence of superciliary tubercles; Tibtars, where on body tibiotarsal projection stretches at adpressed limb; Webbing, webbing formula according to Savage (1975), if it was not possible, extent of webbing on feet is described in words. For references see below.

* An asterisk marks species examined by the authors.

** It is unknown whether the only know specimen of *M. fusca* is male or female.

*** Measurements of F1 in Bain and Nguyen (2004) are different from those of Matsui (2011) used in the present paper.

Sources referenced: 1 — Parker, 1928; 2 — Bain and Nguyen, 2004; 3 — Inger, 1966; 4 — Das and Haas, 2010; 5 — Matsui, 2011; 6 — Pilayi, 1977; 7 — Kuramoto and Joshy, 2006; 8 — Fei et al., 2009; 9 — Andersson, 1942; 10 — Fernando and Siriwardhane, 1996; 11 — Dutta and Manamendra-Arachchi, 1997; 12 — Dutta and Ray, 2000; 13 — Das et al., 2007; 14 — Hasan et al., 2014; 15 — Matsui et al., 2013; 16 — Schenkel, 1901.

of a dark dorsal spot and scapular ocelli and numerous smaller dark spots, pronounced interorbital bar, characteristic alternated light and dark brown stripes, forming a pattern resembling grain of pine-wood, see Figs. 8, 10, 11 (vs. dorsum nearly uniformly colored with a thin middorsal line and few dark spots in *M. heymonsi*, Fig. 2E, see Taylor, 1962; Berry, 1975; own data).

Microhyla pineticola sp. nov. also appears to be similar to the description of *M. fusca* described from "Dalat," Annam, a locality which is quite close to the type locality of the new species described herein (Bidoup Mt.). Since *M. fusca* was described from a single specimen and examination of the holotype was not possible, we can only rely on Andersson's (1942) description. However, despite information given in this paper is far from being detailed, the character states mentioned for *M. fusca* are opposite to what we find in the type series of the new species. The main diagnostic feature on which Andersson relied in his paper is the degree of development of disks on fingers: whereas they are comparatively well-developed in *M. heymonsi*, in *M. fusca* fingers appear to be "slender, tip of third finger is very slightly dilated, tips of other fingers not broader than their median parts" (Andersson, 1942: 9). However in our new species finger disks are developed in not lesser degree than in *M. heymonsi* and are distinct on all three outer fingers (fingers II – IV), moreover a dorsal median groove is seen on all three outer fingers, whereas in *M. fusca* it is seen only on disk of finger III. Disks on toes also appear to be underdeveloped in *M. fusca* compared to our new species (p. 9): "of these [toes] the four outer are dilated to small disks, rather distinct on the fourth, very small on the others" (vs. disks are well developed on all toes, including first toe, disk width of toe IV is subequal to disk width of toe III in *Microhyla pineticola* sp. nov.). The two species can be further distinguished by the following combination of morphological characters: Andersson (1942: 10) indicates that *M. fusca* has shagreened skin with "faint mediodorsal ridge" (vs. smooth skin with no mediodorsal ridge discernible in *Microhyla pineticola* sp. nov.), body habitus is noted as slender (see Andersson, 1942; Bain and Nguyen, 2004) (vs. stout body habitus in the new species), accord-

ing to the original description, the relative length of limbs in *M. fusca* was found to be shorter than in *M. heymonsi*, with tibiotarsal articulation of an adpressed limb reaching to the posterior corner of eye ("marks a hind margin of orbit," and "the hindlimbs shorter than in a specimen of *M. heymonsi* preserved in the collections of R. Nat. Mus. Stockholm" Andersson, 1942: 10), whereas in our new species *Microhyla pineticola* sp. nov. relative length of limbs is significantly greater than those in typical *M. heymonsi*, with tibiotarsal articulation reaching snout or even partially protruding beyond its margin. Unfortunately, Andersson's (1942) description does not contain a detailed description or picture of foot webbing, so we can not use this valuable character for comparison purposes. However he indicates that the toes are "with a well developed web at the bases, more or less distinctly continued as very narrow folds along the sides of the toes" (Andersson, 1942: 9), which is clearly different from basal rudimentary web with no dermal fringes along the toe sides in *Microhyla pineticola* sp. nov. Finally, coloration of the two species seems to be drastically different, according to Andersson's description (1942: 10), *M. fusca* has no clear dorsal pattern, or dorsolateral dark band: "as shown, this species is nearly allied to *Microhyla heymonsi* Vogt, but I cannot identify it with this, as it totally lacks the marked color of this species. The fine white median dorsal line, the "()"-shaped black spots on the back, the sharply defined black lateral band from the tip of the snout to the groin, stated for this species [*M. heymonsi*], are totally absent, and front of thighs and lower surfaces of tarsus and foot are not black." In contrary, all our specimens of *Microhyla pineticola* sp. nov. showed distinct dark dorsal pattern, much more pronounced and variable than those of typical *M. heymonsi*, this includes a vertebral stripe, a dark interorbital bar, dark scapular, inguinal and dorsomedial spots, pronounced dark lateral bands and pinewood like pattern on dorsum (Figs. 8, 10, 11); ventral surfaces of hands and feet have distinct dark-black pattern continuing to ventral surfaces of fingers and toes (Fig. 9). Ventral coloration also appears to be different: in *M. fusca* it is described as "below white, chin bluish black, throat and front part of breast dotted with reddish" (thus confirming that the type specimen apparently did not lost much of its coloration in preservative) vs. yellowish coloration of belly with brownish (but not bluish-black) chin with a distinct light stripe running from chin to chest, no reddish spots on chest and throat in *Microhyla pineticola* sp. nov. (Fig. 10B). Taking all these arguments in consideration we conclude that *Microhyla pineticola* sp. nov. is not conspecific with *M. fusca*; the latter taxon to date is known only from a single specimen and seems to be closely allied to *M. heymonsi* species complex; further field studies in Langbian Plateau and detailed research on phylogenetic structure of the *M. heymonsi* species complex in Indochina are crucial to resolve the taxonomic status of this form.

Microhyla pineticola sp. nov. can also be differentiated from other Southeast Asian and South Asian congeners. It's shovel-shaped inner metatarsal tubercle and stout body habitus separates *M. rubra* (Jerdon, 1854) from the new species. From *M. palmipes* and *M. superciliaris* the new species differs by lacking a supraciliary tubercle, having much less developed foot webbing and the presence of dorsal median grooves on digital disks (vs. having a supraciliary tubercle and fairly developed toe webbing, and lacking the grooves). From *M. achatina* Tschudi, 1838 *Microhyla pineticola* sp. nov. is separated by comparatively longer limbs in *M. achatina*: tibiotarsal articulation reaches just beyond snout (vs. reaches snout in the new species); dorsal coloration: black spot in middle of dorsum absent, two dark cross-bars on limbs (vs. black spot present in middle of dorsum, three to four dark cross-bars on limbs in new species); comparatively less developed foot webbing: webbing formula I 2 – 2½ II 2 – 3¼ III 3 – 4 IV 4 – 3 V (vs. webbing formula I 2 – 2½ II 2 – 3¼ III 3 – 4 IV 4 – 3 V in new species). By comparatively poorly developed basal toe webbing the new species differs from a set of Southeast Asian species: *M. annectens* Boulenger, 1900, *M. fowleri* Taylor, 1934, *M. karunaratnei* Fernando et Siriwardhane, 1996, *M. malang* Matsui, 2011, *M. mantheyi* Das, Yaakob, et Sukumaran, 2007, *M. perparva* Inger et Frogner, 1979 and *M. petrigena* Inger et Frogner, 1979 (all these species show very well developed toe webbing reaching disks or distal subarticular tubercles, see Table 3). From *M. palmipes*, *M. perparva*, *M. petrigena*, and *M. borneensis* Parker, 1928, the new species is further different by a well-developed slightly reduced first finger (vs. first finger greatly reduced and present as a nub or pronounced bulge in these species); from *M. borneensis* the new species can be also easily differentiated by its much larger size in adults: SVL 17.2 – 23.0 in *Microhyla pineticola* sp. nov. vs. 10.6 – 18.8 in *M. borneensis*. From a set of species from Southern and Southeast Asia the new species is separated by a comparatively reduced first finger, its length less than a half of the second finger in *Microhyla pineticola* sp. nov., vs. first finger well developed, it's length more than half of the second finger in *M. chakrapanii* Pillai, 1977, *M. karunaratnei*, *M. maculifera* Inger, 1989, *M. mukhlesuri* Hasan, Islam, Kuramoto, Kurabayashi et Sumida, 2014, *M. mymensinghensis* Hasan, Islam, Kuramoto, Kurabayashi et Sumida, 2014, *M. sholigari* Dutta et Ray, 2000, *M. zeylanica* Parker et Osman-Hill, 1949. Fingers and toes of *Microhyla pineticola* sp. nov. posses distinct disks with dorsal median grooves, what differentiates it from a number of species including *M. chakrapa-*

nii, *M. maculifera*, *M. mukhlesuri*, *M. mymensinghensis*, *M. ornata* (Duméril et Bibron, 1841), *M. rubra* (no disks or dorsal grooves on fingers and toes), and *M. zeylanica* (no disks or dorsal grooves on fingers, weak disks on toes with no grooves). Finally from a recently described *M. orientalis* Matsui, Hamidy et Eto, 2013 the new species differs in larger size (SVL 17.2 – 23.0 in *Microhyla pineticola* sp. nov. vs. 15.8 – 17.4 in *M. orientalis*), stocky body habitus with acuminated snout in profile (vs. slender habitus with rounded snout in *M. orientalis*), dorsal pattern (no black spot in middle of dorsum in *M. orientalis*) and extent of webbing (see Table 3).

Comparison of *M. pineticola* sp. nov. larvae with larvae of *M. heymonsi*. In many aspects of larval external morphology the new species shows some superficial similarities with *M. heymonsi*, including characteristic large silvery iridescent spots on dorsal surface of head between eyes and the mouth being surrounded by a dorsally-oriented funnel with protruding papillae (Fig. 13D, E). However, larvae of the two species differ in body proportions: *M. heymonsi* has a more elongated body (body length to body width rate (BL/BW) is close to 2, and varies from 1.85 to 1.97), whereas *Microhyla pineticola* sp. nov. has a more rounded pyriform body (BL/BW rate is less than 1.5 and varies from 1.37 to 1.45). Distinct differences in mouthparts morphology also separate these species (see Fig. 13D, E): in *M. heymonsi* the funnel formed by the lower labium protrudes far beyond head margin and has a two-lobed shape with a distinct notch in its rostromedial part (Fig. 13E); disk width to body width rate (ODW/BW) always greater than 0.5 and varies from 0.54 to 0.64; round protruding bulges in mouth angles are comparatively less developed. In *Microhyla pineticola* sp. nov. the funnel formed by the lower labium is almost not protruding beyond head margins, has a semicircular shape and lacks a rostromedial notch (Fig. 13D); disk width to body width rate (ODW/BW) varies from 0.33 to 0.4; round protruding bulges in mouth angles are well developed and distinct.

Distribution. Presently known distribution of *Microhyla pineticola* sp. nov. is shown in Fig. 1. The species was recorded at elevations around 860 – 1850 m, in Lam Dong and Dak Lak provinces, Vietnam. The new species is endemic to southern part of the Annamite Mountains in southern Vietnam. The extent of the new species distribution in Vietnam and its population status are not known. Because of the small range in Vietnam, restricted to mountainous areas, the species is vulnerable because of habitat loss due to increased logging, destruction of forests, agricultural activity, road construction and other anthropogenic activities in the area of its distribution. The species is protected in the Bidoup – Nui Ba National Park of Lam Dong Province and the Chu Yang Sin National park of Dak Lak Province. The extent of this species in Vietnam needs to be studied in greater detail

Etymology. Latin for "inhabitant of pine forests," used as a noun in apposition; from Latin "pinetum," the plant sociological term for a pine forest. The specific name is referring to the ecological preference of the new species inhabiting the typical pine forests of the Langbian Plateau, as well as its characteristic dorsal pattern in females, resembling the grain of pinewood (see Figs. 8A and 11A).

Recommended vernacular name. The recommended common name in English is Pine (pigmy) narrow-mouth frog. The recommended common name in Vietnamese is "Nhái bầu Thông."

***Microhyla pulchella* sp. nov.**
Figs. 14 – 19

Synonymy. *Microhyla* sp. 3 — Poyarkov [Paiarkov] and Vassilieva, 2011: pp. 175, 203; Fig. 5.10.

Holotype. ZMMU A-5045 (field number NAP-01814), adult male from the environs of Giang Ly ranger station, Bidoup – Nui Ba National Park, Da Nhim River valley, Da Chais Commune, Lac Duong District, Lam Dong Province, Vietnam (12°10′22.8″ N 108°41′57.12″ E, 1570 m a.s.l.) collected by N. A. Poyarkov on 10 July 2011.

Paratypes. ZMMU A-5068 (field numbers NAP-01815 – 01818, NAP-01820, NAP-01823, NAP-01824), 4 adult males, 3 adult females, collection locality and information same as the holotype, collected by N. A. Poyarkov, A. B. Vassilieva, E. A. Galoyan; ZMMU A-5078 (field numbers NAP-01374 – 01376, NAP-01406), 2 adult males, 2 adult females, collection locality and information same as the holotype; ZMMU A-5079 (no field numbers), 4 adult males, 4 adult females from Hon Giao Mt., southern summit, environs of Hon Giao ranger station, Bidoup – Nui Ba National Park, Da Chais Commune, Lac Duong District, Lam Dong Province, Vietnam (12°11′50.28″ N 108°42′46.44″ E, 1978 m a.s.l.) collected by N. A. Poyarkov and A. B. Vassilieva on 22 June 2010; ZISP 11817 (field number C), a juvenile, from Mt. Bidoup, Bidoup – Nui Ba National Park, Da Nhim River valley, Da Chais Commune, Lac Duong District, Lam Dong Province, Vietnam (12°6′42.48″ N 108°39′33.48″ E, 1924 m a.s.l.), collected by N. L. Orlov on 26 – 29.04.2004; ZISP 11820 (no field number), an adult male, collection locality and information same as the holotype. UNS 5102 (field number DT0003), adult male, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′9.96″ N 108°42′50.4″ E, 1553 m a.s.l.), collected by Tran, T. A. D. on 18 March 2010; ZFMK 95616 (field number

DT007), adult female, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°5′41.64″ N 108°39′37.8″ E, 2027 m a.s.l.), collected by Tran, T. A. D. on 21 March 2010; ZFMK 95617 (field number DT0145), adult female, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°5′46.32″ N 108°39′38.52″ E, 2004 m a.s.l.), collected by Tran, T. A. D. on 18 March 2010; UNS 5103 (field number DT0265), adult female, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°10′58.8″ N 108°40′44.04″ E, 1494 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 20 April 2010; UNS 5104 (field number DT0327), adult male, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′41.28″ N 108°42′44.28″ E, 1908 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 26 April 2010; UNS 5105, 5106 (field numbers DT0325, DT0326), both adult females, from Bidoup — Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′41.28″ N 108°42′44.28″ E, 1908 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 26 April 2010; ZFMK 59618 (field number DT0328), adult female, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′41.28″ N 108°42′44.28″ E, 1908 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 26 April 2010; ZFMK 95619 and UNS 5107 (field numbers DT0351, DT0354), both adult males, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′9.96″ N 108°42′50.4″ E, 1553 m a.s.l.), collected by Tran, T. A. D. on 18 March 2010; UNS 5108 and ZFMK 95623 (field numbers DT0339, DT0356), both adult females, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′9.96″ N 108°42′50.4″ E, 1553 m a.s.l.), collected by Tran, T. A. D. on 18 March 2010; ZFMK 95622 (field number DT0355), adult male, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°11′47.76″ N 108°42′45.36″ E, 1942 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 27 April 2010; ZFMK 95620 and ZFMK 95621 (field numbers DT0352, DT0353), both adult females, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam ((12°11′47.76″ N 108°42′45.36″ E, 1942 m a.s.l.), collected by Tran, T. A. D. and Le, T. T. D. on 27 April 2010; ZFMK 95624 and UNS 5109 (field numbers DT0411, DT0412), both adult females, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Don Province, Vietnam (12°6′5.76″ N 108°40′9.48″ E, 1781 m a.s.l.), collected by Tran, T. A. D. on 10 June 2010; UNS 5110 (field number DT0981), adult male, from Bidoup – Nui Ba National Park, Lac Duong District, Lam Dong Province, Vietnam (12°9′13.68″ N 108°27′49.32″ E, 2048 m a.s.l.), collected by Le, T. T. D. on 07 August 2011.

Referred materials. Series of tadpoles ZMMU A-5046 (field number NAP-02494; stages 28 – 37; 8 specimens) was collected in a small still ephemeral pond near the road Da Lat — Nha Trang, environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam (12°19′55.08″ N 108°40′53.76″ E, 1490 m a.s.l.) by A. B. Vassilieva, N. A. Poyarkov and E. A. Galoyan on 13 July 2011. Larvae are allocated to the new species based on COI DNA-barcoding. A series ZMMU A-5053 (field numbers ABV-00488, ABV-00490, ABV-00491, ABV-00506; 4 adult females; ABV-00489, ABV-00492; 2 adult males) from Mt. Bidoup, Bidoup – Nui Ba National Park, Da Nhim River valley, Da Chais Commune, Lac Duong District, Lam Dong Province, Vietnam (12°6′42.48″ N 108°39′33.48″ E, 1924 m a.s.l.), collected by A. B. Vassilieva on 18 – 20 April 2014.

Diagnosis. *Microhyla pulchella* sp. nov. is characterized by a combination of the following characters: 1) a medium-sized form of *Microhyla*, body moderately stocky; 2) SVL in adult males 14.7 – 21.6 mm, mean 17.40 mm; SVL in females 18.1 – 25.8 mm, mean 23.27 mm; 3) dorsum and flanks smooth; 4) head flat, snout rounded in profile; 5) finger I long, almost equal or slightly less than one-half the length of finger II; 6) tips of three outer fingers weakly dilated, forming weak disks, biggest one on finger III (less than twice the width of phalanges); tips of all toes distinctly dilated into wide disks with narrow peripheral grooves (less than twice the width of phalanges); 7) both finger and toe disks dorsally with weak median longitudinal grooves; 8) inner metacarpal tubercle oval, outer metacarpal tubercle single, rounded and flat; two metacarpal tubercles, inner metatarsal tubercle distinct, oval, length equal to that of the first toe; outer metatarsal tubercle rounded and indistinct; 9) tibiotarsal articulation reaching far beyond snout tip; 10) webbing extensive: full to disks, preaxial side of toes II — IV, postaxial side of toe IV web reaches level of distal subarticular tubercles; at all toes webbing reaches disks as a fringe; 11) upper eyelid without supraciliary spines; 12) top of snout well differentiated in color from the darker interorbital bar; cream stripe from nostril along canthus rostralis ventrally edged with black; whitish stripe extending from rear corner of eye to corner of mouth; thin dark stripe below supratympanic fold continues to dorsolateral dark stripes; 13) vertebral stripe absent; 14) dark dorsal markings extend from interorbital bar to hindlimb

basis and form a double-waisted figure usually broadly outlined in white; two small black scapular spots, two small black dots in the inguinal region, both usually bordered with a thin white line; 15) a narrow, broken, black lateral stripe from above arm to half length of trunk; 16) chin with intense small gray-brown mottling, belly lighter with indistinct grayish mottling; 17) larvae with terminal oral disk, upper labium with slightly prominent lateral lobes, lower labium totally hidden by the overhanging upper labium, tail moderately long, slightly more than one and half body length, tail tip thin and acute without a terminal filament.

Measurements of holotype (in mm). SVL 21.6; HL 6.5; SL 3.0; EL 2.3; N-EL 1.8; HW 7.8; IND 1.9; IOD 2.6; UEW 1.5; FLL 13.9; LAL 10.5; HAL 6.1; 1FL 1.1; IPTL 1.1; OPTL 1.0; 3FDD 0.7; HLL 37.8; TL 13.2; FL 11.8; IMTL 0.8; 1TOEL 2.2; 3TDD 1.2.

Description of holotype. Medium-sized specimen, SVL 21.6 (all measurements in mm); habitus moderately stocky, body oval-shaped (Figs. 14 and 15); head slightly triangular, rounded, slightly wider (7.8) than long (6.5); snout short (3.0), triangularly rounded in dorsal view (Fig. 15A), bluntly rounded in profile, slightly protruding beyond margin of lower jaw (Fig. 15B); eyes protuberant, notably shorter (2.3) than snout (3.0) (EL/SL 0.78) and just slightly shorter than the interoribtal distance (2.6). Top of head flat; canthus rostralis rounded, not distinct; loreal region oblique, weakly concave; nostril round, lateral, on canthus rostralis, notably closer to tip of snout (1.2) than to eye (1.8), interorbital distance wide (2.6), much greater than the internarial distance (1.9), upper eyelid notably narrower (1.5) than the interorbital distance (2.6). Pineal spot absent; tympanum hidden; supratympanic fold weak (Fig. 14A), runs straight from posterior corner of eye to tympanal area and becomes totally indistinct at distance equal to eye diameter. Choanae round, widely spaced, partly concealed under the margin of upper jaw; upper jaw edentate; vomerine teeth absent. Tongue without papillae, roundly spatulate and free at the rear half of its length; slit-like openings to a median vocal sac.

Forelimbs short (13.9) and slender (Figs. 14, 15); lower arm long and slender (10.5), hand (6.1) more than two times shorter than forelimb length (HAL/FLL 0.44). Fingers slender, free of webbing, dorso-ventrally flattened, fingers without skin fringes; the first finger slightly reduced (Fig. 16A), notably less than one-half the length of the second finger, second finger slightly shorter than fourth, latter much longer than first (1.1); relative finger lengths: I < II < IV < III; tips of the three outer fingers slightly dilated forming weak truncated disks, same width as basal phalanges on the fourth and third fingers and slightly narrower than basal phalange on the second

Fig. 14. Holotype of *Microhyla pulchella* sp. nov. (ZMMU A-5045, adult male) in life: (A) dorsolateral view; (B) ventral view. Photos by N. A. Poyarkov.

finger, diameter of the first finger (0.6) is almost as wide as the third finger disk (0.7); narrow peripheral grooves on finger disks poorly developed and present only on the second and third fingers, dorsally tips of the three outer fingers with short poorly-developed median longitudinal grooves, slightly notching finger disks but not producing appearance of two scutes; grooves present in fingers II, III, IV except the first finger; relative finger disk widths: I < IV ≤ II < III; subarticular tubercles on fingers rounded and flattened, distal subarticular tubercles on two outer fingers not very distinct, subarticular tubercle formula 1, 1, 2, 2; nuptial pad absent (Fig. 16A); two metacarpal tubercles: inner metacarpal tubercle distinct, oval and elongated; a single outer metacarpal tubercle (1.0) rounded and prominent, almost same in diameter as the length of inner metacarpal tubercle (1.1).

Hindlimbs slender and long (37.8), less than three times the length of forelimb (HLL/FLL 2.7); tibia long and slender (13.2), around one-third of hindlimb length

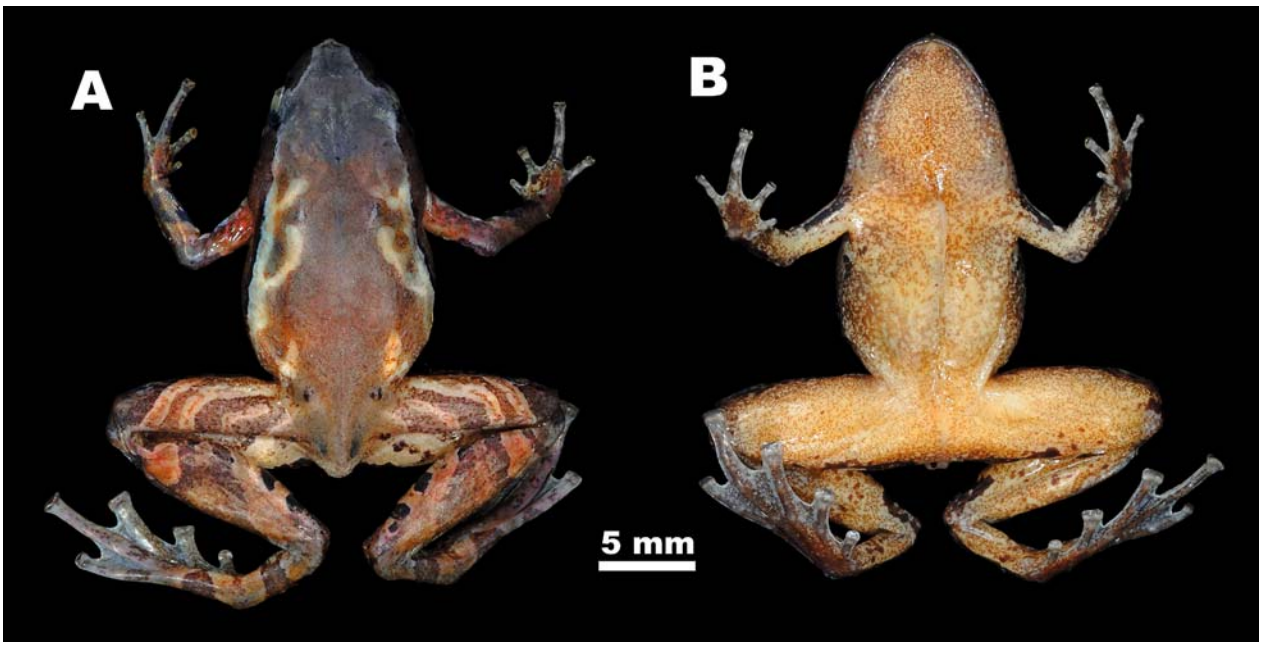

Fig. 15. Holotype of *Microhyla pulchella* sp. nov. (ZMMU A-5045, adult male) in preservative: (A) dorsal view; (B) ventral view. Photos by N. A. Poyarkov.

(TL/HLL 0.35), heels in contact when limbs are held at right angles to body (or overlapping for less than 1 mm); tibiotarsal articulation of adpressed limb reaching well beyond snout; foot (11.8) slightly shorter than tibia length. Relative toe lengths: I < II < III < V < IV; tarsus smooth, inner tarsal fold absent; tips of all toes distinctly dilated into wide truncated disks, much wider than those of fingers (disk diameter of third toe 1.2; 3FDD/3TDD 0.63), disks of all toes with peripheral grooves, dorsally all toe disks with same short median longitudinal grooves as at finger disks; relative toe disk widths: I < V < II < III = IV; webbing between toes fully reaching: preaxial side of toes II – IV, postaxial side of toe IV web reaching distal subarticular tubercles, at all toes web reaches disk as fringe (Fig. 16B), webbing formula: I 1½ – 2 II 1 – 2 III 1 – 2½ IV 2¼ – 1 V; subarticular tubercles on toes round and prominent, formula 1, 1, 2, 3, 2, proximal subarticular tubercle at fourth toe basis not very distinct; metatarsal tubercle single: inner metatarsal tubercle elongated, bean-shaped, prominent, length (0.8) is less than half of first toe (2.2); outer metatarsal tubercle absent.

Dorsal skin smooth above (Figs. 14A and 15A), with a few low tubercles and pustules scattered over dorsal surfaces of limbs, tubercles on hindlimbs larger than those on forelimbs; dorsolateral edges smooth and indistinct, gradually flattened posteriorly; eyelid without supraciliary spines; flanks of body and lateral sides of head smooth; ventral side of body and limbs smooth (Figs. 14B and 15B), vent area smooth. Cloacal opening unmodified, directed posteriorly, at upper level of thighs.

Coloration in life. Dorsal coloration in life orange-red in anterior parts of dorsum and dorsal surface of head getting somewhat darker to reddish-brown posteriorly, dorsal surfaces of forelimbs orange-reddish, hindlimbs brownish or brick-red (Fig. 14A). Dorsum with a distinct pattern: forehead much lighter and brighter than dorsum, orange-yellowish, a distinct red-brownish interorbital bar runs transversally across the head between the most medial parts of upper eyelids, covering the posterior halves of eyelids, with a lighter orange medial spot posteriorly, interorbital bar forms a clear W-shaped figure across the head. A dark mark runs posteriorly from interorbital bar, forming a deep waist at head basis (minimal width of dark mark comparable to width of upper eyelid, UEW), it gets wider in the scapular area and narrows again posteriorly forming a wide waist, continues further posteriorly towards sacrum broadening in the posterior half of dorsum, reaching the anal opening; the brownish pattern on dorsum forms bifurcations with brick-red bands diverging from the medial band towards groin area on right and left sides of the body forming a pattern, resembling a inverted Ψ-shaped mark. Red-brownish pattern on dorsum has irregular borders and is edged with bright-white lines, quite broad in the scapular area and along the dorsolateral edges, getting narrower towards groin (Figs. 14A and 15A). The white edging forms a vermicu-

lated pattern along dorsolateral edges. A pair of small but distinct blackish oval-shaped ocelli present at scapular area (Fig. 14A). No medial round black spot or vertebral stripe present on dorsomedial line. Two smaller black ocelli are present at the sacral area on both sides of body (Fig. 15A). Anterior to anal opening two indistinct darker spots are present along the coccyx. Periphery of upper eyelid edged with a light yellowish supraciliary stripe.

Flanks of body and head not darker than the dorsum, but bearing a more reddish coloration: bright-red on upper jaw, pinkish brick-red on body flanks; no dark lateral stripe present. A continuous thin yellowish dorsolateral stripe runs from snout tip to nostril, gently curving upwards and continues along the edge of canthus rostralis towards upper eyelid, and goes further posteriorly along the dorsolateral edge. Posterior to the level above the axilla, the light dorsolateral stripe is ventrally edged by long irregular black spots forming discontinuous dark dorsolateral lines. The dorsolateral stripe runs below the dorsolateral edges slightly curving ventrally towards the groin area and becomes indistinct in the posterior half of the body. Reddish coloration of body flanks continues ventrally, and dorsally is edged with a series of elongated black spots of irregular shape, which disappear posteriorly at groin area; irregular small rounded black spots edged with white are located on flanks posterior to axilla. Upper jaw bright-red with a row of tiny white spots along the edge of maxilla (Fig. 14A). A narrow cream-yellow stripe extending from posterior corner of eye ventrally and then posteriorly towards axilla, small black spots can be seen dorsally from the cream stripe. The cream stripe reaches axilla and continues to the anterior edge of forearm and runs as far as the elbow. Limbs dorsally with indistinct brick-red or brown pattern: on forearm and lower arm irregular brownish blotches and spots, on thigh and shank brick-red cross-bars: four bars on each thigh and three bars on shank, cross-bars have irregular borders. No dark spots in elbow or knee areas; characteristic double black spots on posterior edges of shanks. Fingers and toes dorsally with indistinct dark spots and blotches.

Ventral surfaces dark colored; belly pinkish to reddish-brown with numerous cream-yellowish small spots scattered across chest and central parts of belly (Figs. 14B, 15B); chin darker, reddish-brown, covered with a thin pinkish reticulation, without any white spots or a light median line; no light medial line on chin. Vent reddish. Limbs ventrally dark reddish-brown with few whitish spots; at ventral surfaces of hand (Fig. 16A) and foot (Fig. 16B) distinct brownish markings, which continue on ventral surfaces of fingers and toes. Iris bright golden with black reticulation; pupil round, black, outlined with a bright golden circle.

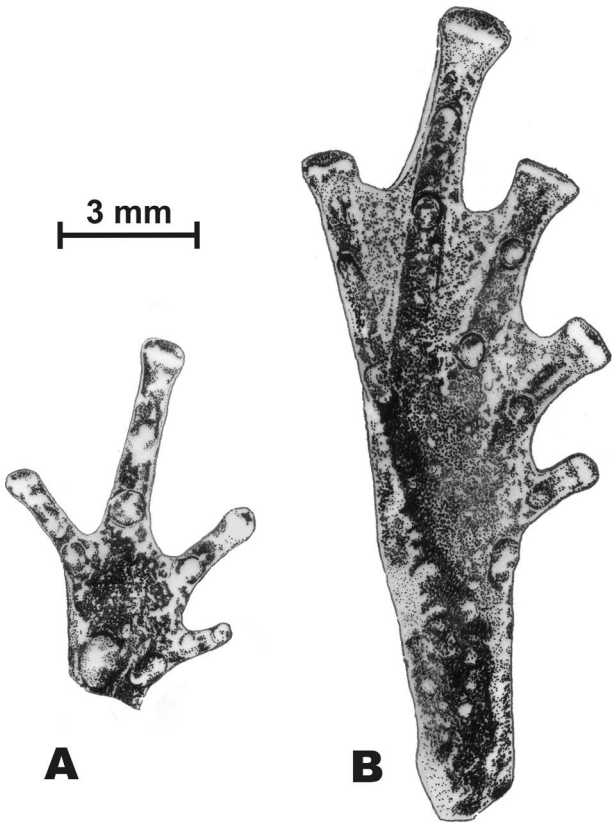

Fig. 16. Holotype of *Microhyla pulchella* sp. nov. (ZMMU A-5045, adult male): (A) palmar view of the right hand; (B) plantar view of the right foot. Drawings by V. D. Kretova.

Coloration in preservative. In preservative the pattern described above has not obviously changed, although color has slightly faded (Fig. 15). Reddish tint faded the most, with reddish colors on dorsal surfaces look brownish or gray-brownish (Fig. 15A); ventral sides look much lighter than in life (Fig. 15B); belly appears cream-yellowish with an irregular brownish spotting.

Variation and sexual dimorphism. Individuals of the type series are generally similar in appearance, but show great variation in coloration, dorsal pattern and in certain characters of external morphology. Variation in size and body proportions is given in Table 1. Males are much smaller than females, SVL 14.7 – 21.6 mm in males ($N = 17$) and 18.1 – 25.8 mm in females ($N = 22$); males with medial gular pouches.

Among the studied type series we found variation in the degree of development of supratympanic folds: it may be indistinct (Fig. 17D; 65% of specimens studied), or fairly distinct (Fig. 17A, C; 20% of specimens studied), or even in some specimens clearly distinct with glandular tubercles arranged in a row along the supratympanic fold (Fig. 17B; 15% of specimens studied).

Fig. 17. Paratypes of *Microhyla pulchella* sp. nov. in life: (A, B) adult males from environs of Giang Ly station, Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam, dorsolateral view; (C, D) adult females from Hon Giao Mt., Bidoup – Nui Ba National Park, Lam Dong Province, Vietnam, dorsalateral view. Photos by N. A. Poyarkov.

Significant variation is found in the degree of development of the outer metatarsal tubercle. It may be present in various conditions: usually it is absent (75% of specimens examined, as in Fig. 16B), in some specimens it is small and conical (15%), or long but with indistinct ranges (10%); no correlation between degree of outer metatarsal tubercle development and sex or reproductive state was found.

Females (Fig. 17C, D) usually show a less bright coloration than males (Fig. 17A, B), with a less pronounced vermiculated, spotted and striped pattern on dorsum. In females, the dorsal surface of head and dorsum is usually yellowish brown (Fig. 17C, D); a dark brown triangular marking may be present (Fig. 17A) or absent (Fig. 17B – D) between eyes and shoulder; back with a large dark brown marking, in butterfly-shape (Fig. 17A, C, D) or disconnected stripes (Fig. 17B); edged with white or cream color (Fig. 17A – C) or not (Fig. 17D). Lateral head reddish to brown; loreal and upper lip dark brown; flank beige, blotched with dark brown or black near groin, blotches may be large (Fig. 17A) or small (Fig. 17C); blotches bordered in cream or white, sometimes connected, forming a broken stripe along the dorsolateral margin (Fig. 17B); lower part brown with dark brown marbling; chin and throat yellowish to reddish brown with white spots; chest and belly with dark gray marbling or speckled in white; limbs brown with dark brown cross-bars above and dark gray marbling below; at the back of thigh sometimes orange yellow, with or without some dark brown spots; vent region dark brown or reddish; undersides of hand and foot dark brown; webbing of fingers and toes brown with dark gray marbling; iris golden or bronze.

Tadpole description.

General morphology. Larval external morphology and coloration is shown in Fig. 18 and 19. Variation in size and body proportions of tadpoles is given in Table 2.

In dorsal view (Fig. 19A), body widely elliptical (BL/BW ratio approximately 0.8 (0.73 – 0.8) with maximum width at gills level; snout almost straight. From lateral view (Figs. 18, 19B), body elliptical, flattened above and rounded below. Tail moderately long, slightly more

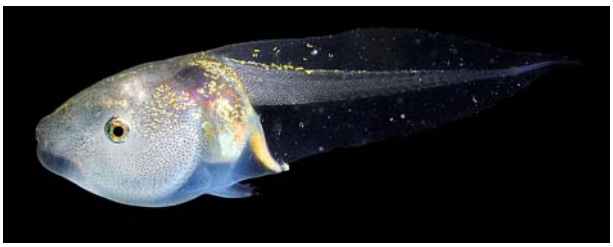

Fig. 18. Tadpole of *Microhyla pulchella* sp. nov. (Stage 28) in life, lateral view. Photo by E. A. Galoyan.

than one and a half of body length: mean TaL/BL 1.57 (1.46 – 1.65), with a weakly developed muscular part; tail tip thin and acute, not forming a terminal filament. Upper fin originating on the dorsal surface of the body and reaching its maximum height in the second third of the tail; lower fin being highest at tail base and exceeding muscular part in height, exceeding upper fin by its maximal height. Spiracle medial, free portion represents a relatively wide membrane with serrated edge ending near the caudal end of belly (see Fig. 19C). Vent tube slightly oblique, opens medially in the beginning of the lower tail fin. Eyes lateral, relatively small (ED/BL 0.12 – 0.13); pupils oriented laterally and slightly ventrally, not visible from dorsal view. Mouth terminal (see Figs. 18 and 19B, D); upper labium with slightly prominent lateral lobes; lower labium is totally hidden by overhanging upper labium. Keratinized elements (denticles, beak) absent. Nostrils not opened at stages available (28 – 37). Lateral line system not visible.

Coloration in life. Body semi-transparent, grayish, with maximal dark pigmentation on the dorsal surface of body and tail stem (Fig. 18). Ventral surface of trunk light, marked by scarce chromatophores; belly surface and spiracle membrane totally unpigmented. In dorsal view, dark intestinal loops partially masked by densely pigmented coelomic lining. Eyes mostly black, iris with golden spots; dark olfactory sacs visible through the skin. Small chromatophores aggregating along the medial line of dorsal surface of trunk forming an elongate dark patch. Tail fins darkly pigmented with reddish coloration along margins, except the totally transparent very distal part.

Natural history notes. The new species was observed in montane evergreen polydominant tropical forests with the predominance of Fagaceae (*Lithocarpus*, *Castanopsis*, *Quercus*), Magnoliaceae (*Manglietia*, *Michelia*), Hamamelidaceae (*Symigtonia*), Elaeocarpaceae (*Elaeocarpus*, *Sloanea*) and other tree species (Kuznetsov et al., 2006), at elevations from 1490 to ~2000 m a.s.l. All frogs were found on the ground, during both day or night.

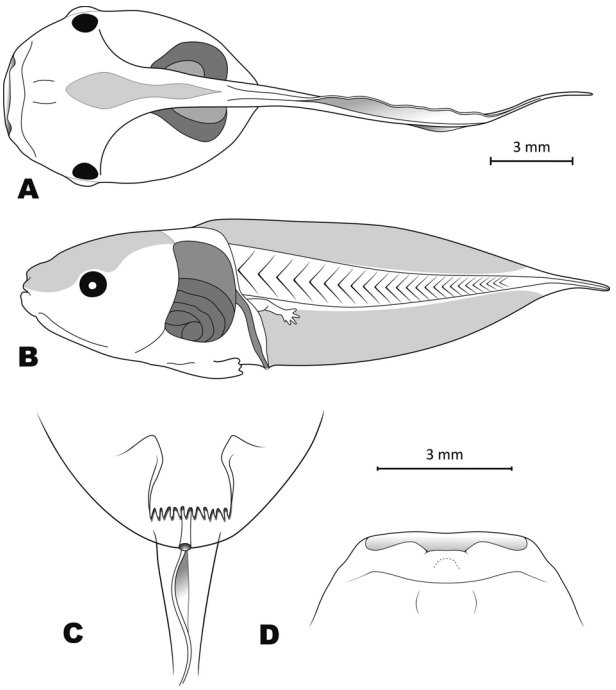

Fig. 19. External morphology of *Microhyla pulchella* sp. nov. tadpole (Stage 37): (A) dorsal view; (B) lateral view; (C) vent area; (D) mouth area (dorsal view). Drawings by A. B. Vassilieva.

Breeding. During the field survey in April 2014 on Bidoup Mt. the first breeding activity was observed on 18 April after a heavy rain at temperatures of ~17ºC and relative humidity of 47%; gravid females, calling males and couples in amplexus were found on the forest floor at a distance of 20 – 50 m from a small cascade forest stream with shallow pools. In still water in temporary ponds tadpoles were swimming in the water column in the day time, forming loose groups numbering several tens of individuals.

Syntopic batrachofauna. In the montane evergreen forests of Bidoup – Nui Ba National Park the new species co-occurs with following anuran species (see Poyarkov and Vassilieva, 2011): *O.* cf. *hansi*, *I. galeatus*, *X. major*, *H. montivaga*, *M. annamensis*, *R. gryllus*, *R. vampyrus*, *T. palliatum*; the breeding activity of *Microhyla pulchella* sp. nov. was recorded at the same sites with *O.* cf. *hansi*, *L. leucops*, *L. pullum*, *Leptolalax bidoupensis* Rowley, Le, Tran et Hoang, 2011 (at elevations ~1900 m a.s.l.) and with *M. annamensis* and *F. palpebralis* (at elevations of about 1500 m a.s.l.).

Comparisons. The new species *Microhyla pulchella* sp. nov. is compared below with all known congeners (morphological characters and distribution data for each species are summarized in Table 3).

A set of morphological characters clearly separates *Microhyla pulchella* sp. nov. from all of its Indochinese and East Asian congeners. The presence of a well developed foot webbing, reaching toe disks (or distal subarticular tubercles further to disk as fringe on preaxial sides of toes II — IV and postaxial side of toe IV) in *Microhyla pulchella* sp. nov. clearly differs this taxon from *Microhyla* species with rudimentary or basal foot webbing not reaching toe disks or distal subarticular tubercles, as it is found in *M. fissipes* (Fig. 2D), *M. fusca*, *M. heymonsi* (Fig. 2E), *M. mixtura*, *M. okinavensis*, *M. picta* (Fig. 2G), *M. pulchra* (Fig. 2F), and sympatric *Microhyla pineticola* sp. nov. (Figs. 10 and 11). The new species is further differentiated from *M. fissipes* by having IO/UEW rate 1.48 – 2.26 (vs. interorbital distance wider than upper eyelid in *M. fissipes*); possessing two flat palmar tubercles, the inner oval and the outer round (vs. three metacarpal tubercles present in *M. fissipes*). The presence of pronounced wide disks on fingers and toes with weak dorsal median grooves in *Microhyla pulchella* sp. nov. distinctly separates the new species from *Microhyla* species lacking finger and toe disks: *M. fissipes*, *M. okinavensis*, *M. pulchra*, and *M. picta*; the latter species is further differentiated from the new species by a stout habitus, larger body size, SVL 25.2 – 33.4, and presence of a large shovel-like metatarsal tubercle (vs. moderately stocky body habitus, smaller body size, SVL 14.7 – 25.8 and no enlarged metatarsal tubercle in *Microhyla pulchella* sp. nov.). The new species can be easily distinguished from another Indochinese species *M. butleri* (Fig. 2C) by the following set of characters: body habitus stout, dorsum skin very smooth, first finger somewhat reduced and its length is smaller than a half of second finger, hindlimbs long: tibiotarsal articulation of adpressed limb reaches far beyond snout in *Microhyla pulchella* sp. nov. (vs. slender body habitus, dorsum skin with prominent reddish tubercles, first finger well developed, greater than half of second finger length, legs short: tibiotarsal articulation of adpressed limb doesn't reach snout in *M. butleri*). The new species can be easily differentiated from the sympatric *M. annamensis* (Fig. 3) by its smooth skin with no tubercles, bright dorsal coloration in males and pronounced discontinuous or continuous black dorsolateral stripes in both sexes, and a comparatively greater extent of webbing, webbing formula I 1½ – 2 II 1 – 2 III 1 – 2½ IV 2¼ – 1 V (vs. very tubercular and warty skin, not bright brownish dorsal coloration with no dark dorsolateral stripes, comparatively less developed foot webbing (I 1 – 2¼ II 1 – 2½ III 1½ – 2¾ IV 3 – 1 V) in *M. annamensis*). From the sympatric species *M. berdmorei* (Fig. 2A, B) the new species is different in many aspects, first of all by its bright dorsal coloration, its much smaller size (SVL 14.7 – 25.8), moderately stocky body habitus with the snout bluntly rounded in profile, and a comparatively less degree of toe webbing, with web reaching to distal subarticular tubercles on preaxial sides of toes II – IV and postaxial side of toe IV, further to disks as fringe (vs. grayish-brown dull body coloration, large body size (SVL 23.8 – 45.6), slender habitus with snout obtusely pointed in profile, web reaching to disks at all toes but toe IV: I 1 – 1 II 1 – 2 III 1 – 2 IV 2 – 1 V in *M. berdmorei*). From *M. nanapollexa* the new species is different by the dorsal coloration pattern and its comparatively well-developed first finger (vs. first finger greatly reduced and present as a nub or pronounced bulge in *M. nanapollexa*).

Among all other species of Indochinese *Microhyla* the new species is most similar to *M. marmorata* (Fig. 2H) and *M. pulverata* (central Vietnam) and assumingly is a member of one complex with these taxa, sharing such characters as a well-developed toe webbing, pronounced disks on fingers and toes, comparatively long hindlimbs. From both *M. marmorata* (Fig. 2H) and *M. pulverata* the new species is different in its dorsal coloration, which is very bright in males of *Microhyla pulchella* sp. nov., often with reddish and orange colors (vs. darker brownish or grayish dorsal coloration in *M. marmorata* and *M. pulverata*), and dark dorsal pattern, which always forms a continuous dark irregular figure joining the interorbital bar with a dark figure on dorsum and scapular area in the new species (Figs. 14 and 17) (vs. interorbital bar and dark dorsal figure always separated by a lightly colored gap in scapular area, so the dark dorsal figure always has a sharp anterior form of an arrow pointing towards head basis in *M. marmorata* (Fig. 2H; Bain and Nguyen, 2004: p. 509, Fig. 2A) and *M. pulverata* (Bain and Nguyen, 2004: p. 514, Fig. 3A). From *M. marmorata* the new species can be further distinguished by its dark reddish-brown ventral coloration with numerous tiny whitish spots, see Fig. 14B (vs. characteristic dark chin and belly heavily marbled by large black and white blotches, see Bain and Nguyen, 2004: p. 509, Fig. 2B, a pattern never observed in the type series of *Microhyla pulchella* sp. nov.), lack of the characteristic dark spot on the anterior surface of lower arm (vs. present in *M. marmorata*), by coloration of iris: iris golden with black reticulation in the new species, see Fig. 14A (vs. iris golden with clear darker spots in dorsal and ventral parts of iris, see Fig 2H, in *M. marmorata*) and by peculiarities of foot webbing, which is comparatively more developed in *Microhyla pulchella* sp. nov., webbing formula: I 1½ – 2 II 1 – 2 III 1 – 2½ IV 2¼ – 1 V (vs. comparatively less developed toe webbing, formula I 1 – 2 II 1 – 1¾ III 1½ – 2¾ IV 2¾ – 1 V in *M. marmorata*).

From *M. pulverata* the new species can be further separated by its comparatively narrower head and shorter snout (see Table 1), median HL/HW rate 0.95 (vs. comparatively wider head and longer snout, median HL/HW rate 0.98 in *M. pulverata*), in webbing (for *M. pulverata* webbing on toe IV full to medial subarticular tubercle, on toe III full to distal subarticular tubercle on postaxial side, webbing formula I 1 – 2 II 1 – 2½ III 1¾ – 3 IV 3 – 1 V; for *Microhyla pulchella* sp. nov. webbing full for 1/4 of phalanx length beyond the level of medial subarticular tubercle of toe IV, and to disk for postaxial side of toe III; for webbing formula see above and Table 3), by normally one metatarsal tubercle discernible (second metatarsal tubercle absent in 75% of specimens studied) (vs. two metatarsal tubercles discernible in *M. pulverata*). *Microhyla pulchella* sp. nov. is slightly larger than *M. pulverata*, SVL up to 25.8 mm (vs. SVL up to 20.2 mm in *M. pulverata*). *Microhyla pulchella* sp. nov. is also different from *M. pulverata* in peculiarities of dorsal coloration: presence of white vermiculations along dorsolateral edges (vs. absence in *M. pulverata*), legs with three to four dark cross-bands (vs. legs with one dark cross-band in *M. pulverata*). *Microhyla pulchella* sp. nov. has comparatively more massive hands and wider digital disks than *M. pulverata*.

Microhyla pulchella sp. nov. can also be differentiated from other Southeast Asian and South Asian congeners. Three diminutive small-bodied species from the Sundas differ from *Microhyla pulchella* sp. nov. in having the first finger greatly reduced present as a pronounced bulge: *M. borneensis* (SVL 10.6 – 18.8), *M. perparva* (SVL 10.5 – 14.5), and *M. petrigena* (SVL 13.9 – 17.8); the other small-sized species from Sundas, *M. palmipes* (SVL 16.0 – 21.8) can be differentiated from the new species by having first finger present as a small free nub and lacking dorsal median longitudinal grooves of digital disks. A number of South and Southeast Asian species can be easily separated from the new species in having reduced basal foot webbing, reaching the level of proximal subarticular tubercles or less: *M. achatina*, *M. borneensis*, *M. chakrapanii*, *M. mukhlesuri*, *M. mymensinghensis*, *M. orientalis*, *M. ornata*, *M. rubra*, the latter species is also different by its stout habitus and well-developed shovel-like outer metatarsal tubercle. *M. achatina* can be further distinguished from the new species by having a obtusely pointed snout and the presence of a light vertebral stripe (vs. rounded snout and no vertebral stripe in *Microhyla pulchella* sp. nov.). A number of species can be easily distinguished from *Microhyla pulchella* sp. nov. by lacking digital disks and dorsal median grooves on digits: *M. chakrapanii*, *M. fowleri*, *M. maculifera*, *M. mukhlesuri*, *M. mymensinghensis*, *M. ornata*, *M. rubra*, *M. zeylanica*; *M. maculifera* can be further separated from the new species by its diminutive size (SVL 11.8 – 12.3) and by having first finger longer than half of second finger (vs. first finger shorter than half of second in new species). *M. malang* differs from *Microhyla pulchella* sp. nov. in possessing three dark brown spots on the upper lip (absent or sometimes present as white spots in *Microhyla pulchella* sp. nov.) and having a less extensive webbing (does not reach the disks of toes III or V). *M. annectens* lacks an outer metatarsal tubercle and is smaller than *Microhyla pulchella* sp. nov. (SVL 14.4 – 18.4), this species also has better developed webbing than in the new species (see Table 3), and has a slender body habitus (vs. moderately stocky body habitus in new species). *M. mantheyi* differs from the new species by having snout cream-colored, pointed snout and granular or feebly pustular skin on dorsum (vs. snout orange or brown with dark spots and clear interorbital bar, rounded snout smooth dorsal skin in *Microhyla pulchella* sp. nov.). *M. superciliaris* Parker, 1928 and *M. palmipes* can be separated from the new species by possessing supraciliary tubercles on upper eyelids (vs. no tubercles on upper eyelid in *Microhyla pulchella* sp. nov.). Finally, *M. karunaratnei* (SVL 15.8 – 21.0) and *M. sholigari* (SVL 11.0 – 15.0) have smaller body sizes and can be further differentiated from the new species by the well-developed first finger which is longer than the half of the second finger, and less developed toe webbing, check formulas in Table 3 (vs. first finger length less than the half of second finger length and complete toe webbing in *Microhyla pulchella* sp. nov.).

Distribution. Presently known distribution of *Microhyla pulchella* sp. nov. is shown in Fig. 1. During the surveys, this frog was found in the montane evergreen forests of Bidoup – Nui Ba National Park at altitudes 1500 – 2050 m a.s.l. (Hon Giao and Bidoup Mts.). The new species is endemic to the Langbian Plateau in the southern part of the Annamite Mountains in southern Vietnam. *Microhyla pulchella* sp. nov. seems to be associated with highland wet evergreen forests of Langbian Plateau. Because of the small range in Vietnam, restricted to highland mountainous areas above 1500 m a.s.l., the species seem to be vulnerable to habitat loss due to increased deforestation and other anthropogenic activities in the area of its distribution. The extent of the new species distribution in Vietnam and its population status is not known. So far the species was recorded only from the territory of Bidoup – Nui Ba National Park in Lam Dong Province, but possibly can be found on the neighboring parts of Khanh Hoa and Ninh Thuan provinces.

Etymology. The specific name "*pulchella*" is a Latin adjective in the nominative singular, in feminine, a diminutive from "*pulcher*" — "beautiful"; "*pulchellus*" means "handsome," "pretty" referring to a remarkable

colorful and bright coloration of adult males in the new species (see Fig. 14A) as well as to its medium body size.

Recommended vernacular name. The recommended common name in English is Pretty (pigmy) narrow-mouth frog. The recommended common name in Vietnamese is "Nhái bầu Đẹp."

Microhyla minuta **sp. nov.**
Figs. 20 – 26

Synonymy. *Microhyla* aff. *palmipes* — Tarkhnishvili, 1994: 3 – 62; Tarkhnishvili, 1995: 123 – 129; Bain and Nguyen, 2004: 520 (partim).

Holotype. ZMMU A-5047 (field number NAP-02072), adult male from Cat Tien National Park, road from park headquarters to Bau Sau Lake, Dong Nai River valley, Dac Lua Commune, Tan Phu District, Dong Nai Province, Vietnam (coordinates 11°26′20.04″ N 107°24′12.6″ E, elevation 157 m a.s.l.), collected by E. A. Galoyan on 12 September 2011.

Paratypes. ZMMU A-5048 (field numbers NAP-02073, NAP-02074; NAP-02091 – 02094; NAP-02096, NAP-02097), 8 adult males from the same locality, date and collector information the same as for the holotype; ZMMU A-5048 (field numbers NAP-02095, NAP-02098), 2 adult females from the same locality, collected on 17 September 2011 by E. A. Galoyan; ZISP 11812 (field number NAP-02090), an adult male from the same locality, date and collector information the same as for the holotype; ZFMK 96230 (field number 10343, adult male) from Cat Tien National Park, Dong Nai River valley, "Heavenly Rapids Road ~2 km beyond Rapids" (Paul Moler, personal communication), Dac Lua Commune, Tan Phu District, Dong Nai Province, Vietnam, collected by Paul Moler on 06 June 2004 and IEBR A.2013.113 (field number 10309, adult female), from the vicinity of the headquarters of Cat Tien National Park, Dong Nai River valley, Dac Lua Commune, Tan Phu District, Dong Nai Province, Vietnam, collected by Robert Wayne Van Devender on 21 May 2004.

Referred materials. Series of tadpoles ZMMU A-5049 (field number NAP-02248; stages 31 – 36; 4 specimens; description based on 8 specimens, stages 26 – 36), reared from egg clutch obtained in laboratory on the night of 18 September 2011 from an adult pair collected by E. A. Galoyan on 17 September 2011. Fresh egg clutch was obtained from a pair in amplexus collected in a spawning pond – a shallow ephemeral pool near the road from the headquarters of Cat Tien National Park to Bau Sau Lake, Dong Nai River valley, Dac Lua Commune, Tan Phu District, Dong Nai Province, Vietnam (coordinates 11°26′20.04″ N 107°24′12.6″ E, elevation 157 m a.s.l.).

Diagnosis. *Microhyla minuta* sp. nov. is characterized by a combination of the following characters: 1) a small-sized *Microhyla*, body very slender; 2) SVL in adult males 14.7 – 15.9 mm in, mean 15.26 mm; SVL in adult females 15.7 – 17.2 mm, mean 16.64 mm; 3) skin on dorsum slightly granular, sometimes feebly pustular; 4) head triangular, narrow; snout bluntly rounded in profile; 5) finger I long, almost equal or slightly less than one-half the length of finger II; 6) tips of the three outer fingers very weakly dilated, forming weak disks (less than three times the width of phalanges); tips of toes dilated into weak, slightly expanded disks (less than three times the width of phalanges); 7) finger disks dorsally with weak median longitudinal grooves; toe disks with clear dorsal median longitudinal grooves producing the appearance of two scutes; 8) inner metacarpal tubercle single, rounded; outer metacarpal tubercle paired; two metatarsal tubercles, both low, rounded and short; 9) tibiotarsal articulation at straightened limb reaching beyond eyes but not reaching snout tip; 10) webbing basal: rudimentary web present between toes II and III reaching the level of proximal subarticular tubercles, all other phalanges free of webbing; 11) upper eyelid without supraciliary spines; 12) top of snout undifferentiated from the brown forehead, interorbital bar slightly darker; a cream stripe below supratympanic fold from rear corner of eye to axilla, bordered by thin brown lines above and below; 13) vertebral stripe absent; 14) dark dorsal markings form triple-waisted figure with two characteristic yellow ")("-shaped scapular marks in males; 15) unclear series of dark grayish or blackish spots form indistinct lateral stripes from above arm to half length of trunk; 16) chin dark, heavily mottled with dark gray-brown tiny spots, belly much lighter, whitish with indistinct dark dots in the chest region; 17) in larvae oral disk forms a dorsally oriented funnel, upper labium elevated, oral flaps form prominent rounded lobes in each mouth corner, lower labium bears an umbelliform disk; tail long, more than twice the body length, with muscular part moderately developed and a thin terminal filament.

Measurements of holotype (in mm). SVL 15.3; HL 5.3; SL 1.8; EL 1.8; N-EL 0.9; HW 4.6; IND 1.4; IOD 1.9; UEW 1.1; FLL 9.1; LAL 6.9; HAL 4.2; 1FL 1.0; IPTL 0.4; OPTL 0.6; 3FDD 0.5; HLL 26.7; TL 8.5; FL 9.2; IMTL 0.5; 1TOEL 1.4; OMTL 0.4; 3TDD 0.6.

Description of holotype. Small-sized specimen, SVL 15.3 (all measurements in mm); body habitus moderately slender, body elongated oval-shaped (Figs. 20 and 21); head triangular, notably longer (5.3) than wide (4.6); snout short (1.8), rounded in dorsal view (Fig. 20A) and bluntly rounded in profile, slightly projecting beyond lower jaw (Figs. 20C, 21B); eyes comparatively large, protuberant in dorsal view, same length

(1.8) as snout (1.8) (EL/SL 1.0) and subequal to interorbital distance (1.9). Top of head rather flat, canthus rostralis rounded, indistinct; lore sloping, very weakly concave; nostril round, lateral, on canthus rostralis, closer to tip of snout (0.7) than to eye (0.9), interorbital distance (1.9) greater than internarial distance (1.4), the latter larger than width of upper eyelid (1.1). Pineal spot absent; tympanum hidden; no supratympanic fold discernible. Choanae large, rounded and not widely spaced; no maxillary teeth; vomer edentate, tongue oval, without papillae and free in its rear half; slit-like openings to a median vocal sac.

Forelimbs short (9.1) and very thin; lower arm long and slender (6.9), comprising three fourths of forelimb length, hand (4.2) over two times shorter than forelimb length (HAL/FLL 0.46). Fingers very thin, free of webbing, rounded in cross-section, no skin fringes on fingers present; first finger well-developed (Fig. 22A), almost the same length as one-half of the length of the second finger, second finger subequal to fourth, latter much longer than first (1.0); relative finger lengths: I < II = IV < III; tips of three outer fingers slightly dilated and forming weak flattened disks almost same width or narrower than basal phalanges, diameter of first finger (0.3) greater than a half the diameter of third finger disk (0.5); all disks bearing clear peripheral grooves, dorsally finger tips bear weak median longitudinal grooves producing the appearance of a shallow notch on finger tips, grooves present in fingers II, III, IV except the first finger; relative finger disk widths: I < II = IV < III; subarticular tubercles on fingers round and flat with somewhat unclear edges (tubercles can be best seen because they lack melanophores), formula 1, 1, 2, 2; nuptial pad absent (Fig. 22A); inner metacarpal tubercle round, slightly flattened; a paired outer metacarpal tubercle divided by a waist into two equal-sized parts, both flat and rounded; diameter of outer metacarpal tubercle (0.6) larger than inner metacarpal tubercle (0.4).

Hindlimbs moderately long (26.7), about three times the length of forelimb (HLL/FLL 2.9); tibia long (8.5), around one-third of hindlimb length (HLL/TL 0.32), heels largely overlapping when limbs are held at right angles to body; tibiotarsal articulation of adpressed limb reaching snout: beyond the level of nostril but not reaching beyond the snout tip; foot (9.2) notably longer than tibia. Relative toe lengths: I < II < V < III < IV; third toe longer than fifth; tarsus smooth, no inner tarsal fold; tips of all toes slightly dilated into narrow disks, of roughly same width than those of fingers (disk diameter of third toe 0.6; 3FDD/3TDD 0.8) and narrower than the basis of phalanges of the respective toes; dorsally all toes bear clear median longitudinal grooves at disks producing the appearance of two scutes; relative toe disk widths: I < V

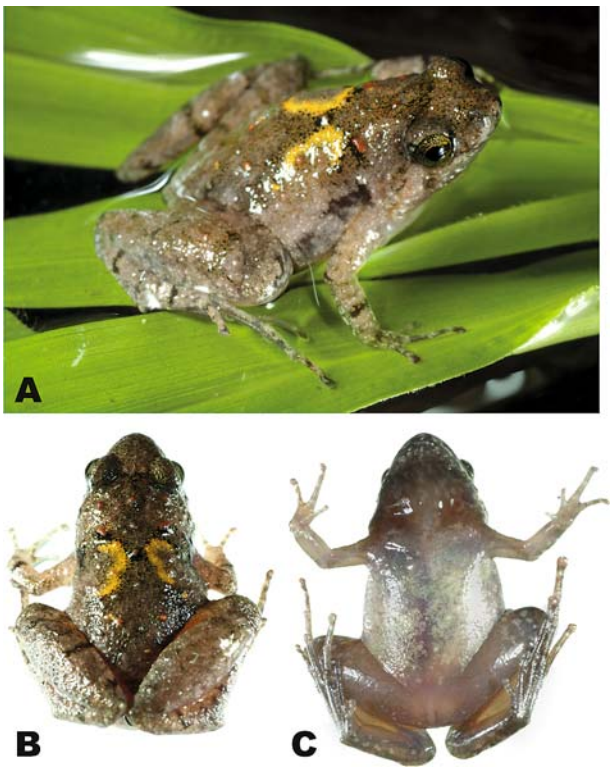

Fig. 20. Holotype of *Microhyla minuta* sp. nov. (ZMMU A-5047, adult male) in life: (A) dorsolateral view; (B) dorsal view; (C) ventral view. Photos by E. A. Galoyan.

< II = III = IV; webbing between toes basal and almost absent (Fig. 22B), rudimentary webs present between second and third toe reaching the level of proximal subarticular tubercles, webbing formula: I n.a. – n.a. II 2 – 3½ III 3 – 4 IV 4 – 3 V; subarticular tubercles on toes well developed, similar to those on fingers but more prominent and rounded, subarticular tubercle formula 1, 1, 2, 3, 2; inner metatarsal tubercle small, oval-shaped, very well distinct, length (0.5) is slightly less than one third of first toe length (1.4); outer metatarsal tubercle rounded, elevated and well-prominent with clear edges, its diameter slightly smaller (0.4) than length of inner metatarsal tubercle.

Dorsum skin feebly granular above (Figs. 20A, B and 21A), with prominent pustules and smaller tubercles uniformly scattered all over dorsal surfaces, larger tubercles are observed on dorsal surfaces of mid-body, dorsal surfaces of head and forelimbs are covered with scarce smaller granules, dorsal surfaces of hindlimbs are covered with pustules similar to those on dorsum, but somewhat smaller, dorsolateral edges flat and not prominent; eyelid without supraciliary spines or granules; flanks of body and lateral sides of head smooth, may be slightly

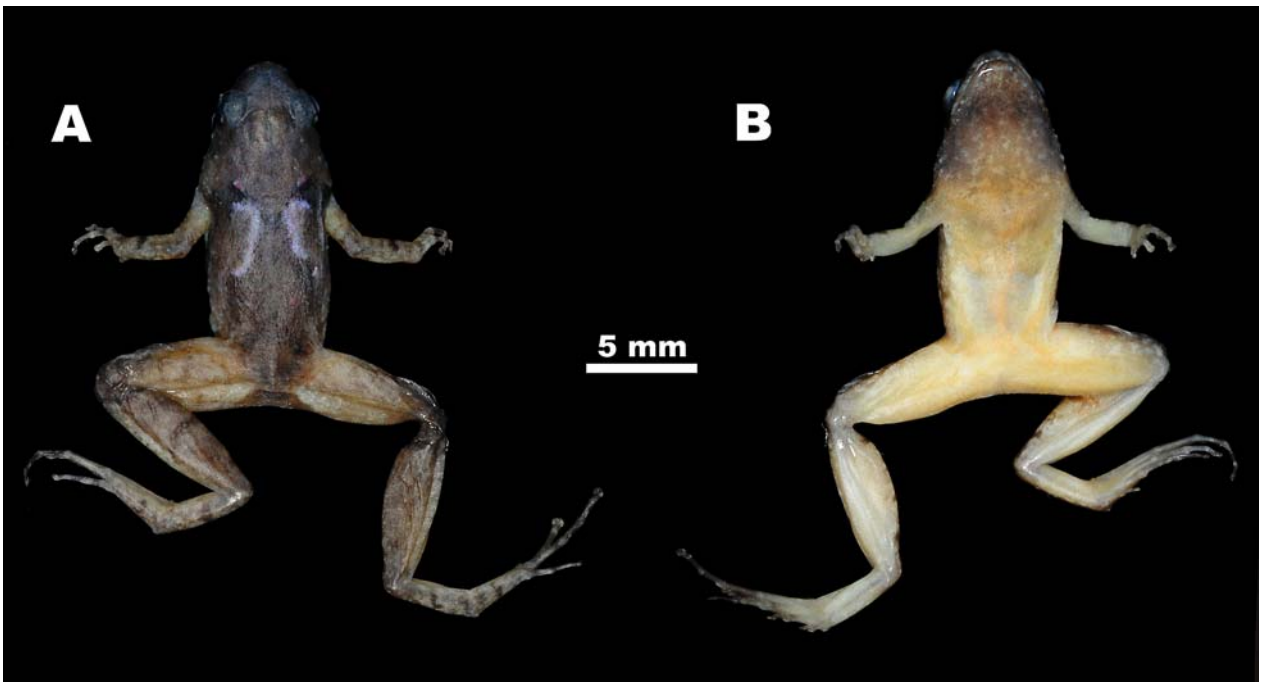

Fig. 21. Holotype of *Microhyla minuta* sp. nov. (ZMMU A-5047, adult male) in preservative: (A) dorsal view; (B) ventral view. Photos by N. A. Poyarkov.

shagreened (see Fig. 20B); ventral side of body and limbs smooth (Figs. 20C and 21B), vent smooth. Cloacal opening unmodified, directed posteriorly, at upper level of thighs.

Coloration in life. In life dorsum colored in olive-grayish or brownish colors without a distinct dark pattern (Fig. 20A, B). Dark-gray interorbital bar indistinct, present as a vague irregular grayish line between posterior parts of upper eyelids, not forming a triangular pattern. From head basis two narrow darker gray-olive lines run posteriorly and join together at scapular region, forming an indistinct brown-olive waisted pattern resembling a cross, this darker figure forms two darker lines running ventrally towards limb insertions on each body side, the posterior part of the pattern gradually widens posteriorly forming four indistinct darker bars running laterally towards groin and sacrum area on each body side to form a double wide-limbed reverse V-shaped mark in posterior half of back. A pair of distinct black spots present at scapular area (Fig. 20A, B), the spots are of a semi-crescent shape bordered posteriorly by two characteristic large oval-shaped prominent pinkish warts, which are quite prominent. A distinct round black spot bordering a round pinkish wart present on dorsomedial line little posterior to scapular area, approximately at the point of one half of SVL (Fig. 20A, B). Additional pinkish or reddish tubercles and pustules are scattered across the back, smaller tubercles are found at head basis and larger tubercles in the rear part of dorsum. No signs of a light vertebral line discernible. Two characteristic crescent-shaped bright-yellow lines are present on dorsum in the scapular area posterior to dark scapular spots and tubercles. Each of the yellow scapular lines laterally border the dark-olive cross-like mark, forming a distinct ")("-shaped figure. Yellow scapular lines have sharp borders and are about 0.3 – 0.4 mm in width. No light spots or markings on upper eyelid present.

Flanks of body and head lighter than the dorsum, without distinct dark lateral stripes, background coloration pinkish or beige (Fig. 20A). No dark stripe on snout discernible, loreal region near the anterior corner of eye dark-brown. Upper jaw brownish with irregular a whitish or pinkish mottling and spots. Supratympanic area uniform gray-brown, without dark markings. Posterior to the insertion of forelimb a dark-brown blotch of irregular shape runs posteriorly and ventrally, irregular dark-gray marbling present in the groin area and on body flanks. A short pinkish-cream stripe runs from posterior corner of eye to axilla and continues to anterior edge of fore arm. Except for the upper arm, limbs dorsally with narrow indistinct gray-olive cross-bars: three to four bars on both lower arms, three to four bars on each thigh and shank; their borders are unclear. Fingers and toes dorsally with grayish transverse bars.

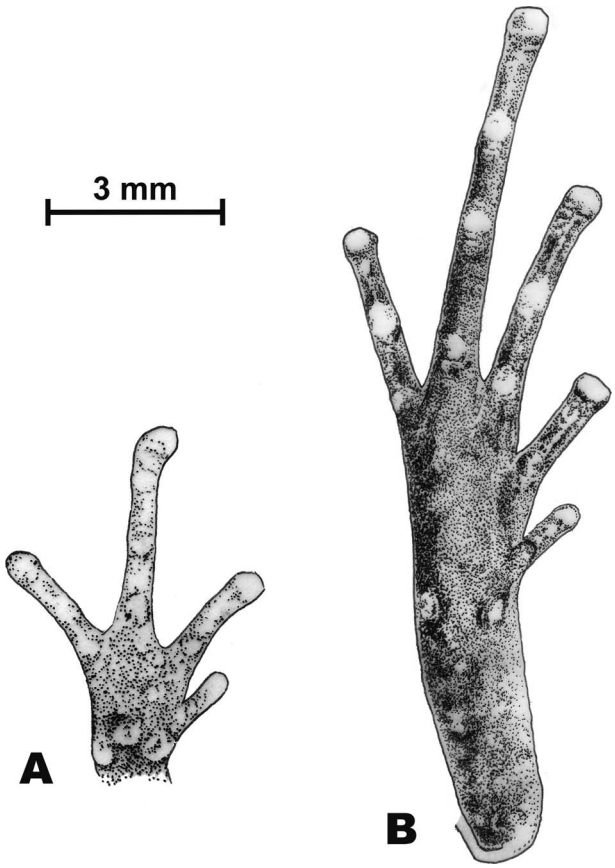

Fig. 22. Holotype of *Microhyla minuta* sp. nov. (ZMMU A-5047, adult male): (A) palmar view of the right hand; (B) plantar view of the right foot. Drawings by V. D. Kretova.

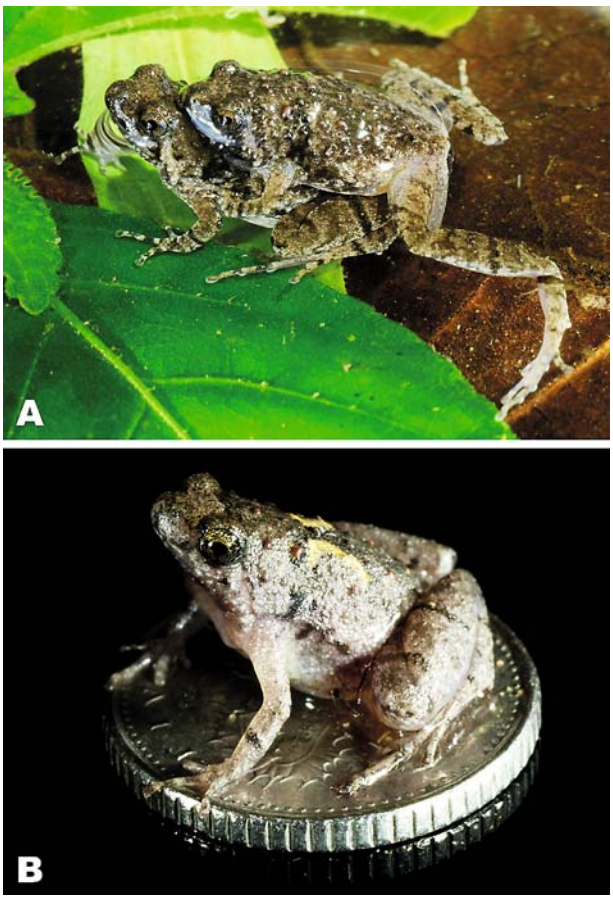

Fig. 23. Type specimens of *Microhyla minuta* sp. nov.: (A) pair in amplexus in situ in Cat Tien National Park, Dong Nai Province, Vietnam (ZMMU A-5048); (B) holotype (ZMMU A-5047, adult male) on a dime coin showing its actual size. Photos by E. A. Galoyan.

Ventral surfaces show a contrasted coloration with the throat being distinctly darker than the belly; belly cream colored, nacreous-white with bluish and pinkish tints, medial part of belly pinkish-gray; no dark spots or mottling seen on ventral surfaces (Fig. 20C); chin dark grayish-pink with an irregular whitish spotting in the posterior parts of chin and chest, throat notably darker along margins of lower jaw and mouth angles; no light medial line from chin to chest discernible. Limbs ventrally pink or reddish; grayish with no clear darker pattern at ventral surfaces of hand (Fig. 22A) and foot (Fig. 22B). Iris bronze with a greenish-brown reticulation, darkly pigmented at anterior and posterior corners; pupil round, black, outlined with a bronze circle.

Coloration in preservative. In ethanol the pattern described above has not obviously changed, although color has slightly faded (Fig. 21), especially yellow and pink colors. In preservative (Fig. 21) the dark dorsal pattern became much more obvious than in life (Fig 20B). Upper eyelids became bluish-gray. The characteristic ")("-shaped dorsal pattern totally lost its yellow color and became whitish (Fig. 21A). Pinkish and nacreous-white colors on ventral sides totally disappeared, belly and ventral sides of limbs look creamy-yellowish, and throat appears gray with a whitish mottling (Fig. 21B).

Variation and sexual dimorphism. Individuals of the type series are generally similar in appearance. Variation in size and body proportions is given in Table 1. Females larger than males: SVL 14.6 – 15.9 mm in males ($N = 11$) (Figs. 20, 21, 23, and 24), 15.7 – 17.2 mm in females ($N = 3$) (Fig. 23A); slit-like openings to a median subgular vocal sac present in males. Two of three examined female specimens lack characteristic yellow ")("-shaped dorsal pattern, typical for males of this species, but in the single female specimen (IEBR A.2013.113; field number 10309) very short yellow markings are present on dorsum. However, male paratypes show great variation in their dorsal coloration

Fig. 24. Variation in coloration in the type series of *Microhyla minuta* sp. nov. (ZMMU A-5048; males): (A) dorsal view; (B) ventral view; not to scale. Photos by E. A. Galoyan.

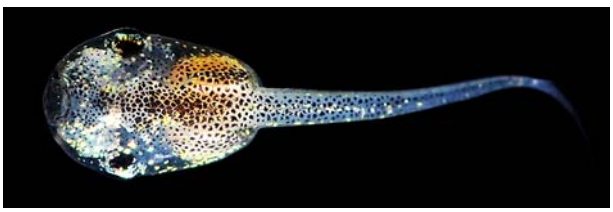

Fig. 25. Tadpole of *Microhyla minuta* sp. nov. (Stage 26) in life, dorsal view. Photo by E. A. Galoyan.

pattern (see Fig. 24A). In the majority of males the yellow ")("-shaped dorsal pattern is very distinct, however in some specimens it is more distinct than in the holotype, runs from scapular area to sacrum and forms a "<>"-shaped figures; in other specimens certain levels of reduction of yellow markings can be found; in one male a yellow line is present on the left side of body, whereas on the right side it is reduced to a small yellow spot; in another male specimen the yellow pattern as well as all dark dorsal markings are totally absent. There is a notable variation in the belly patterns (Fig. 24B). In four males white spots are well-developed and form a marbling pattern. In other males the dark coloration of the throat is very pronounced, and black spots cover chin and chest areas, whereas in the other male specimens only marginal parts of the throat bear dark pigmentation (Fig. 24B).

Tadpole description.

General morphology. Tadpole coloration in life is shown in Fig. 25, details of tadpoles external morphology is shown in Fig. 26. Variation in size and body proportions of tadpoles is given in Table 2.

In dorsal view (Figs. 25 and 26A), body elliptical, nearly pyriform, with head part larger than belly (maximum width behind eyes, at gill level; mean BW/BL 0.6 (0.53 – 0.8)); snout with a prominent central part. From lateral view (Fig. 26B), body elliptical, flattened above and rounded below. Tail long, more than twice the body length (mean TaL/BL = 2.17 (2.0 – 2.4), with muscular part moderately developed and a thin terminal filament. Muscular portion at the tail base nearly equal in height to the lower fin. Upper fin originating posteriorly to the tail base and reaching its maximum height in the second third of tail; lower fin highest in the proximal half of the tail and exceeding the upper fin by its maximal height. Spiracle medial, free portion is an elongate, relatively narrow membrane with slightly triangular edge ending near the posterior end of belly (see Fig. 26B, C). Vent tube oblique, opens medially in the beginning of the lower tail fin. Eyes lateral, relatively big (eye diameter about 0.15 times the body length, ED/BL 0.14 – 0.17); pupils oriented laterally and slightly ventrally, visible from below. Mouth opening wide, rounded, and located on the dorsal surface of the snout. Oral disk forming a dorsally oriented funnel (see Fig. 26D); upper labium elevated, oral flaps forming prominent rounded lobes in each mouth

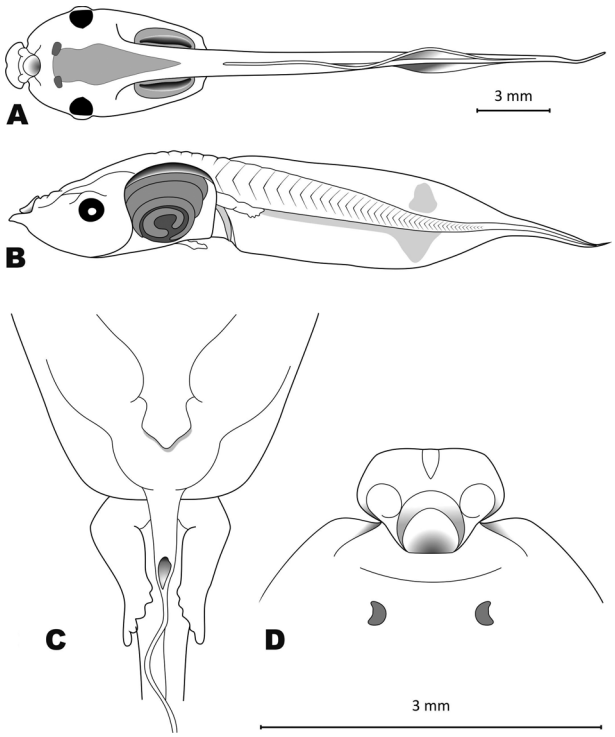

Fig. 26. External morphology of *Microhyla minuta* sp. nov. tadpole (Stage 36): (A) dorsal view; (B) lateral view; (C) vent area; (D) mouth area (dorsal view). Drawings by A. B. Vassilieva.

Fig. 27. Natural habitat of *Microhyla minuta* sp. nov. in a mixed semideciduous monsoon tropical forest in Cat Tien National Park, Dong Nai Province, Vietnam. Photo by E. A. Galoyan.

corner; lower labium bearing an umbelliform disk; enlarged infralabial flange bearing one prominent central papilla. Keratinized elements (denticles, beak) are absent. Nostrils not opened at stages available (26 – 36); small pigmented protuberances seen on their place (Fig. 26A). Lateral line system not visible.

Coloration in life. Dorsal surface of body and tail darkly pigmented, trunk with small golden spots (Fig. 25). Two small black patches on the head part above the olfactory capsules. Iris with golden shine. The pigmented dorsal coelomic lining forming two short dark stripes along the tail muscles extending on the trunk; lateral and ventral body walls semitransparent, with scattered chromatophores making a small aggregation in the free spiracle valve; gills and intestinal loops well visible. Tail fins mostly transparent, with a distinct pigmented patch on the distal half of tail; thin terminal portion unpigmented.

Natural history notes. The new species was observed in lowland forests up to 200 m a.s.l. in the area 2 – 5 km around the Cat Tien National Park headquarters. Here the new species was mostly found in dense monsoon tropical semideciduous forests with closed canopy, dominated by *Lagerstroemia calyculata* (Lythraceae), *Afzelia xylocarpa* (Fabaceae), and *Dipterocarpus alatus* (Dipterocarpaceae) (see Fig. 27). Most specimens of the *Microhyla minuta* sp. nov. type series were collected during the end of the rainy season between 12 and 20 of September. During continuous field studies in Cat Tien National Park throughout the year since 2009, specimens or calls of the new species were never registered in other months. Only two paratypes collected in 2004 were observed in May and June.

Breeding. Massive breeding was observed on 17 September 2011. Males initiated vocalization at warm nights (23 – 24°C) after strong rains (30 – 60 mm, 99% humidity) approximately at 16:00 and kept on calling until at least 24:00. While calling, males stayed at ground surface near the water edge of temporary pools with thick grass; sometimes males were observed to call from small hollows or depressions in the ground or from grass leaves above the water surface. The distance between calling

males was usually around 1 m or less. Pools used for breeding were located along the main road in Cat Tien National Park headquarters and in the forest patches on clay soils. Vocalization was similar to that of syntopic *Microhyla heymonsi*; however for the human ear it appeared higher in frequency. Eggs were laid by clusters numbering several tens. Recently laid eggs floated on the water surface not sticking together; they were small [mean ovum diameter 1.0 (0.78 – 1.2; $N = 5$)] and bicolored on early stages of cleavage, with a brown upside and a creamy-white underside. One clutch was reared in laboratory to observe larval development.

Embryonic period took 47 – 48 h, hatching tadpoles stand near the water surface or near the aquarium walls. Tadpoles started active feeding just two or three days after hatching; they were fed by minced standard flaked alevins food and reared until stage 36. Larvae were observed to take the food from the water surface.

Syntopic batrachofauna. During the reproduction period daily activity of *Microhyla minuta* sp. nov. was recorded in the same water pools with *Kalophrynus interlineatus* (Blyth, 1855), *Kaloula pulchra* Gray, 1831, *M. heymonsi*, *M. fissipes*, *M. berdmorei*, and *M. erythropoda*. *Occidozyga martensii* (Peters, 1867) was also observed in the same pools, but no parallel breeding activity was recorded.

Comparisons. Below we compare *Microhyla minuta* sp. nov. with all known congeners (morphological characters and distribution for each species are summarized in Table 3).

A suite of morphological characters clearly differentiates *Microhyla minuta* sp. nov. from all other *Microhyla* species known to date for the territory of Vietnam. The miniature size of the new species is among the most obvious differences. Anuran species that are under 15 mm are defined as "diminutive," "minute," or "miniature" (Estrada and Hedges, 1996; Biju et al., 2007; Duellman and Hedges, 2008) and frogs of the genus *Microhyla* are among the smallest Asian anurans (Das and Haas, 2010). However all presently known diminutive species of *Microhyla* (with males reaching 15 mm or smaller: *M. annectens*; *M. borneensis*; *M. perparva*; *M. petrigena*) are confined to Borneo or Malaya (see Table 3). SVL in males of *Microhyla minuta* sp. nov. varies around 15.3 mm (14.7 – 15.9) and thus the new species is much smaller than other Vietnamese congeners known to date. Another character which allows distinguishing the new species from all Indochinese congeners is the characteristic ")("-shaped bright yellow marks on the dorsum in males, not reported for any other *Microhyla* species known for the region (however, note significant variation in dorsal coloration shown in Fig. 24).

The new species can be also distinguished from all other *Microhyla* species known from Indochina and East Asia by the following combination of morphological features. Broad webbing reaching toe disks or distal subarticulars separates the following Indochinese congeners from the new species: *M. annamensis*, *M. berdmorei*, *M. butleri*, *M. fowleri*, *M. marmorata*, *M. nanapollexa*, *M. pulchra*, *M. pulverata*, and *Microhyla pulchella* sp. nov. (vs. basal webbing present between second and third toes reaching the level of proximal subarticular tubercles in *Microhyla minuta* sp. nov.). Well developed digital disks with median grooves on the dorsal surface separate the new species from a number of congeners, which lack such disks and grooves: *M. fissipes*, *M. okinavensis*, *M. pulchra*, and *M. picta*. The latter species can be also easily distinguished from *Microhyla minuta* sp. nov. by its large body size (SVL 25.2 – 33.4 mm), its stout habitus (Fig. 2G) and the well-developed shovel-like outer metatarsal tubercle (vs. small body size, slender habitus, outer metatarsal tubercle not enlarged in the new species), whereas *M. pulchra* has a distinct Λ-shaped dorsal pattern and a yellowish groin (Fig. 2F) (vs. no Λ-shaped dorsal pattern or yellow coloration in groin in *Microhyla minuta* sp. nov.). The Chinese species *M. mixtura* can be easily separated from the new species by a suite of morphological features, which include the following: Stout body habitus and large body size (SVL 20.5 – 26.6), absence of dorsal longitudinal grooves on finger disks (vs. miniature body size, weak dorsal longitudinal grooves present on finger disks in *Microhyla minuta* sp. nov.) and a more expanded foot webbing (see Table 3 for details). From species of the *M. heymonsi* species complex the new species can be distinguished by its smaller size (SVL 14.7 – 17.2 mm), by the usual presence of yellow ")("-shaped markings on dorsum in males, by the absence of a dorsomedial vertebral light stripe, being typical for members of this complex and by its comparatively granular skin on dorsum covered with low pustules (vs. shagreened or smooth skin in members of *M. heymonsi* complex). *Microhyla minuta* sp. nov. is further separated from *M. fusca* by a combination of the following characters: snout bluntly rounded, expanded disks present on the three outer fingers (vs. snout acuminate, disk only on finger III in *M. fusca*). *M. heymonsi* and *M. pineticola* sp. nov. can be further distinguished from the new species by their smooth skin, the presence of characteristic a medial dark spot and a light vertebral line on dorsum, the dark (almost black) coloration of body and head flanks, forming a dark lateral stripe from tip of snout to groin (vs. granular skin, no dark medial spot and light vertebral line on dorsum, no dark lateral stripes in *Microhyla minuta* sp. nov.).

The new species can be distinguished from other congeners from southern and Southeast Asia by a set of morphological features. From all other species — by the peculiar yellow ")(”-shaped dorsal marking (not reported for any other member of the genus *Microhyla*). The broad foot webbing reaching disks or at least the distal subarcticular tubercles separate the following congeners from the new species: *M. annectens*, *M. karunaratnei*, *M. malang*, *M. mantheyi*, *M. perparva*, *M. petrigena*, *M. superciliaris*, and *M. zeylanica*. The presence of well-developed digital disks in *Microhyla minuta* sp. nov. separates the new species from a set of congeners: *M. chakrapanii* (no finger disks, only toe disks present), *M. maculifera* (no finger disks, only weak toe disks present), *M. mukhlesuri*, *M. mymensinghensis*, *M. ornata*, *M. zeylanica* (no finger disks, only toe disks present) and *M. rubra*. The latter species can be further easily distinguished from the new species by its stout habitus and the enlarged outer metatarsal tubercle. Among the remaining species of the genus, the following lack median longitudinal grooves on disks: *M. palmipes*, *M. perparva* (grooves present on toe disks only), *M. sholigari* (grooves present only on toe disks), *M. superciliaris* (weak grooves present on toe disks only) (vs. grooves present on digital disks in *Microhyla minuta* sp. nov.). The presence of distinct supraciliary tubercles separate *M. palmipes* and *M. superciliaris* from the new species. A well developed first finger in *Microhyla minuta* sp. nov. clearly differentiates the new species from other diminutive *Microhyla* species having first finger greatly reduced to a nub or a bulge: *M. borneensis*, *M. palmipes*, *M. perparva*, and *M. petrigena*. *M. achatina* is differentiated from the new species in having the snout obtusely pointed in profile, the heel of adpressed limbs reaching the snout or beyond and the presence of a distinct dorsomedial vertebral stripe (vs. snout rounded, heel of adpressed limb shorter than snout, no vertebral stripe in *Microhyla minuta* sp. nov.). Finally, the new species appears to be morphologically quite similar to *M. orientalis* recently described from Bali, however this species can be separated from *Microhyla minuta* sp. nov. by having a faint vertebral line, slightly shorter limbs with heels of adpressed limbs reaching only the eye level and their peculiarities of toe webbing, formula I n.a. – n.a. II 2 – 3¼ III 3 – 4¼ IV 4¼ – 3 V (vs. vertebral line absent, heel of adpressed limb reaching beyond the eye, I n.a. – n.a. II 2 – 3½ III 3 – 4 IV 4 – 3 V).

Distribution. To date the new species is only known from Dong Nai Province in southern Vietnam. *Microhyla minuta* sp. nov. is endemic to lowland dipterocarp monsoon tropical forests in southern Vietnam. *Microhyla minuta* sp. nov. is protected in the Dong Nai Biosphere Reserve (Nam Cat Tien sector of Cat Tien National Park); 20-years old records by Tarkhnishvili (1994; 1995) from Ma Da forestry (western part of Dong Nai Province) likely correspond to our new species. The discovery of *Microhyla minuta* sp. nov. in neighboring areas of Lam Dong, Binh Phuoc and Binh Duong provinces in Vietnam is anticipated. The extent of the distribution in Vietnam and its population status is not known in detail. However, due to the small distribution range, restricted to rare fragments of lowland tropical forest, the species seem to be highly vulnerable to habitat loss due to increased destruction of lowland forests, agriculture and other anthropogenic activities.

Etymology. The specific name "*minuta*" is an adjective in the nominative singular, in feminine, from Latin "minutus" — "small," "tiny," referring to a remarkably small body size of the new species (see Fig. 23B), which is among the smallest frog species known for Indochina.

Recommended vernacular name. We propose the following common name: Tiny (pigmy) narrow-mouth frog. The recommended common name in Vietnamese is "Nhái bầu nhỏ."

Microhyla darevskii **sp. nov.**
Figs. 28 – 31

Holotype. ZISP 7370 (field number ZISP 21396), adult male from above Mang Xang Village, environs of Ngoc Linh Mountain, Dac Choong Commune, Dac Glei District, Kon Tum Province, Vietnam (15°4′59.88″ N 107°57′0.36″ E, elevation 1500 m a.s.l.), collected on 15 September 1998 by Nikolai L. Orlov.

Paratypes. ZISP 7311 (field number ZISP 21394), ZISP 7372 (field number ZISP 21395), 2 adult males, and ZMMU A-5050 (field numbers ZISP 21397, 27398), 2 adult males, collection data are the same as for the holotype.

Diagnosis. *Microhyla darevskii* sp. nov. is characterized by a combination of the following characters: 1) a large-sized form of *Microhyla*, body habitus moderately slender, triangular in shape and strongly flattened; 2) SVL in adult males 27.0 – 32.6 mm, mean 30.04 mm; 3) dorsum slightly tubercular or pustulate; 4) head broad, triangular; snout rounded in profile; 5) finger I long, more than one half of the length of finger II; 6) disks on fingers totally absent; tips of toes also lacking disks, though sometimes weakly dilated; 7) toes with short dorsal median longitudinal grooves; 8) outer palmar tubercle single and flattened; two metatarsal tubercles, inner short and rounded, outer rounded and slightly projecting; 9) tibiotarsal articulation reaching far beyond the snout tip; 10) webbing well developed, at all toes reaching toe disks; 11) upper eyelid without supraciliary spines; 12) top of snout slightly lighter than the brown

Fig. 28. Holotype of *Microhyla darevskii* sp. nov. (ZISP 7370, adult male) in life: (A) dorsolateral view; (B) lateral view showing groin area. Photos by N. L. Orlov.

interorbital bar; a white cream bar below the supratympanic fold extending from the rear corner of eye to the axilla, not bordered in black dorsally; 13) vertebral stripe absent; 14) dark dorsal markings unclear brown blotches, slightly bordered in light brown; 15) wide grayish lateral stripe with unclear borders from above arm to the middle of trunk; 16) chin light grayish brown with tiny spots, belly whitish.

Measurements of holotype (in mm). SVL 32.6; HL 10.1; SL 4.7; EL 3.6; N-EL 2.4; HW 11.2; IND 3.1; IOD 4.6; UEW 2.5; FLL 18.8; LAL 13.2; HAL 8.3; 1FL 3.5; IPTL 1.4; OPTL 2.0; 3FDD 0.5; HLL 60.1; TL 19.8; FL 23.2; IMTL 1.7; 1TOEL 4.0; OMTL 0.9; 3TDD 1.2.

Description of holotype. Large-sized specimen, SVL 32.6 (all measurements in mm); body habitus stocky, body strongly triangular and greatly flattened dorsoventrally (Figs. 28 and 29); head triangular in dorsal view, transition between head basis and body indistinct, head fairly wider (11.2) than long (10.1); snout comparatively long and prominent (4.7), triangularly rounded in dorsal view (Fig. 29A), gently rounded in profile view, well protruding beyond the margin of the lower jaw (Fig. 29B); eyes large, protuberant, notably shorter (3.6) than snout (4.7) (EL/SL 0.77) and much shorter than the interoribtal distance (4.6). Top of head gently sloping, with medial part of head basis slightly raised (Fig. 28); canthus rostralis rounded, fairly distinct; lore sloping, notably concave; nostril oval-shaped, orientated laterally, below canthus rostralis, notably closer to the tip of snout (1.3) than to the eye (2.4), interorbital distance comparatively small (4.6), slightly larger than internarial distance (3.1) (IND/IOD 0.67), upper eyelid (2.5) about two times smaller than the interorbital distance (UEW/IOD 0.55). Pineal spot absent; tympanum hidden; supratympanic fold very distinct, marked by a row of low tubercles (Fig. 28), runs posteriorly and ventrally from posterior corner of eye to the tympanal area, near mouth edge the fold curves backwards and runs straight to the insertion of the forelimb. Choanae triangular-shaped, equilateral, widely spaced, not concealed under the margin of the upper jaw; maxilla edentate; no vomerine dentigerous processes. Tongue without papillae, wide, truncated, spatulate with a gentle notch in its posterior free end, tongue free at the rear four fifths of its length; slit-like openings to a median vocal sac present.

Forelimbs short (18.8) and thin (Figs. 28 and 29); lower arm long and slender (13.2) (LAL/FLL 0.70), hand (8.3) more than two times shorter than the forelimb length (HAL/FLL 0.45). Fingers slender and long, round in cross-section, free of web, skin fringes on fingers absent; first finger not reduced and very well developed (Fig. 30A), notably more than one-half the length of the second finger; second finger as long as the fourth, latter much longer than first (3.5); relative finger lengths: I < II = IV < III; tips of all fingers rounded, not dilated to disks, finger tips notably narrower than their basal phalanges, diameter of the first finger (0.6) slightly greater than the width of the third finger tip (0.5); peripheral grooves on finger tips absent, no signs of median longitudinal grooves on dorsal surface of finger tips discernible; finger tips of almost equal in width, first finger tip little narrower; subarticular tubercles on fingers distinct, large, round and prominent, distal subarticular tubercles on fourth finger less distinct, subarticular tubercle formula 1, 1, 2, 2; nuptial pad absent (Fig. 30A); two metacarpal tubercles: inner metacarpal tubercle distinct, prominent, round in shape; a single outer metacarpal tubercle (2.0) rounded and flattened, notably greater in diameter than the inner metacarpal tubercle (1.4).

Hindlimbs long (60.1), over three times of the length of the forelimb (HLL/FLL 3.2); femur thick and muscular (Fig. 29), tibia of moderate length and slender (19.8),

around one-third of hindlimb length (TL/HLL 0.33), heels largely overlap when limbs are held at right angles to body; tibiotarsal articulation of adpressed limb reaching far beyond the snout tip; foot long (23.2), over one third of hindlimb length (HLL/FL 0.39) and notably longer than the tibia length (TL/FL 0.86). Relative toe lengths: I < II < V ≤ III < IV, third finger almost as long or slightly longer as the fifth finger; tarsus smooth, inner tarsal fold absent; tips of all toes distinctly dilated into small round disks, slightly wider than finger tips (disk diameter of third toe 1.2; 3FDD/3TDD 0.65), peripheral grooves on toe disks not discernible, dorsally all toe disks bear deep and fairly wide median longitudinal furrows, dividing the toe tip into two parts producing the appearance of two scutes; relative toe disk widths: I < V < II < III = IV; third toe longer than fifth; webbing between toes fully developed, reaching to disks at all toes, at preaxial side of toe III and postaxial side of toe IV web reaches the disk as a wide fringe (Fig. 30B), webbing formula: I 1 – 1 II 1 – 1 III 1 – 1 IV 1 – 1 V; subarticular tubercles on toes prominent, oval-shaped, distinctly raised in their distal part and somewhat flattened at their proximal part; subarticular tubercle formula 1, 1, 2, 3, 2, all tubercles very distinct; two metatarsal tubercles: inner metatarsal tubercle of moderate size, oval-shaped, slightly elongated, indistinct with unclear edges, length (1.7) less than one half of first toe length (4.0) (IMTL/1TOEL 0.43); outer metatarsal tubercle small (0.9) but very distinct, round, prominent with clearly defined edges, its diameter around a half of the inner metatarsal tubercle length (OMTL/IMTL 0.5).

Skin on dorsum slightly tubercular above (Figs. 28 and 29A), with low round pustules that continue on flanks, a row of round tubercles denote the dorsolateral edges, dorsal surface of forelimbs almost smooth with tiny granules at forearm, dorsal surface of hindlimbs clearly postulate with low round pustules scattered over the dorsal surfaces of femur and tibia; the latter pustules notably smaller than those on dorsal surfaces; dorsolateral edges distinct, gradually flattening posteriorly (Fig. 28B); upper eyelid smooth without tubercles or supraciliary spines; flanks of body smooth, lateral sides of head with numerous small warts around the tympanal area, denoting the supratympanic fold; ventral side of body and limbs smooth (Fig. 29B), vent smooth. Cloacal opening unmodified, directed posteriorly, at upper level of thighs.

Coloration in life. Dorsal coloration in life olive brown dorsally with a bronze tint on lateral sides of dorsum, with a clear darker brownish dorsomedial pattern in shape of a butterfly (Fig. 28A), this pattern has irregular borders and is edged with a thin cream line. A distinct brown interorbital bar in shape of a reverse triangle with irregular borders runs transversally across the head between the posterior parts of the upper eyelids, spreading to posterior third of eyelids. A dark mark runs posteriorly from interorbital bar and sharply narrows at the head basis forming a deep waist (at the waist area the dorsomedial marking has a width subequal to the width of the upper eyelid). The dark marking continues posteriorly and broadens at the scapular area and narrows again at the middle of dorsum, forming a second waist; from this point two pairs of dark stripes run laterally and posteriorly — towards groin and sacrum in the shape of a double inversed "V"; the lateral pair of dark bands becomes indistinct at groin (Fig. 28B), and the medial pair of dark bands continues posteriorly running down on the dorsal surface of thighs. No signs of black ocelli, a dorsomedial spot, a dorsomedial vertebral line; lateral sides of dorsum lighter and bronze in color. A pair of dark-brown marks bordered with beige present above the anal opening, forming a trapezoid dark spot around the anus. No supraciliary spots or stripes on upper eyelids.

Flanks of body and head slightly darker than the lateral sides of dorsum, but in the same color as in the medial parts. No dark lateral stripes or spots at the edge of canthus rostralis discernible; snout uniformly olive-brown. From the posterior edge of eye along the supratympanic fold a wide olive-bronze band gradually widens towards the insertion of forelimb and along the dorsolateral edge towards groin. Olive-brownish coloration of lateral stripe gradually turns paler ventrally, and is dorsally bordered by the brighter bronze-brown color of the dorsolateral edges, which disappears posteriorly at groin area (Fig. 28B). Upper jaw dark brown with few irregular lighter brownish or cream spots below the eye level. A narrow cream stripe runs from posterior corner of eye to axilla. Except for upper arm, limbs dorsally with indistinct brownish cross-bars and spots with very unclear edges (at hindlimbs borders with a cream line); two bars seen on lower arms, three bars on each thigh and shank. No black spot in elbow or knee area. Fingers and toes bearing brown transverse bars dorsally.

Ventral surfaces lightly colored; belly and chest cream-white, with few irregular grayish spots in the chest area (Fig. 29B); throat colored dark, chin covered with a dense dark gray spotting, its color being notably darker along the margins of the lower jaw and mouth angles and gradually turns lighter to pinkish gray towards the chest; no medial line on chin or chest. Limbs ventrally without spots or any distinct pattern, forelimbs ventral surfaces pinkish or beige, hindlimbs ventral sides beige, pinkish or somewhat bluish gray, no distinct pattern on ventral surfaces of hands (Fig. 30A) and feet (Fig. 30B). Iris bronze with a black reticulation, no dark pigmentation at

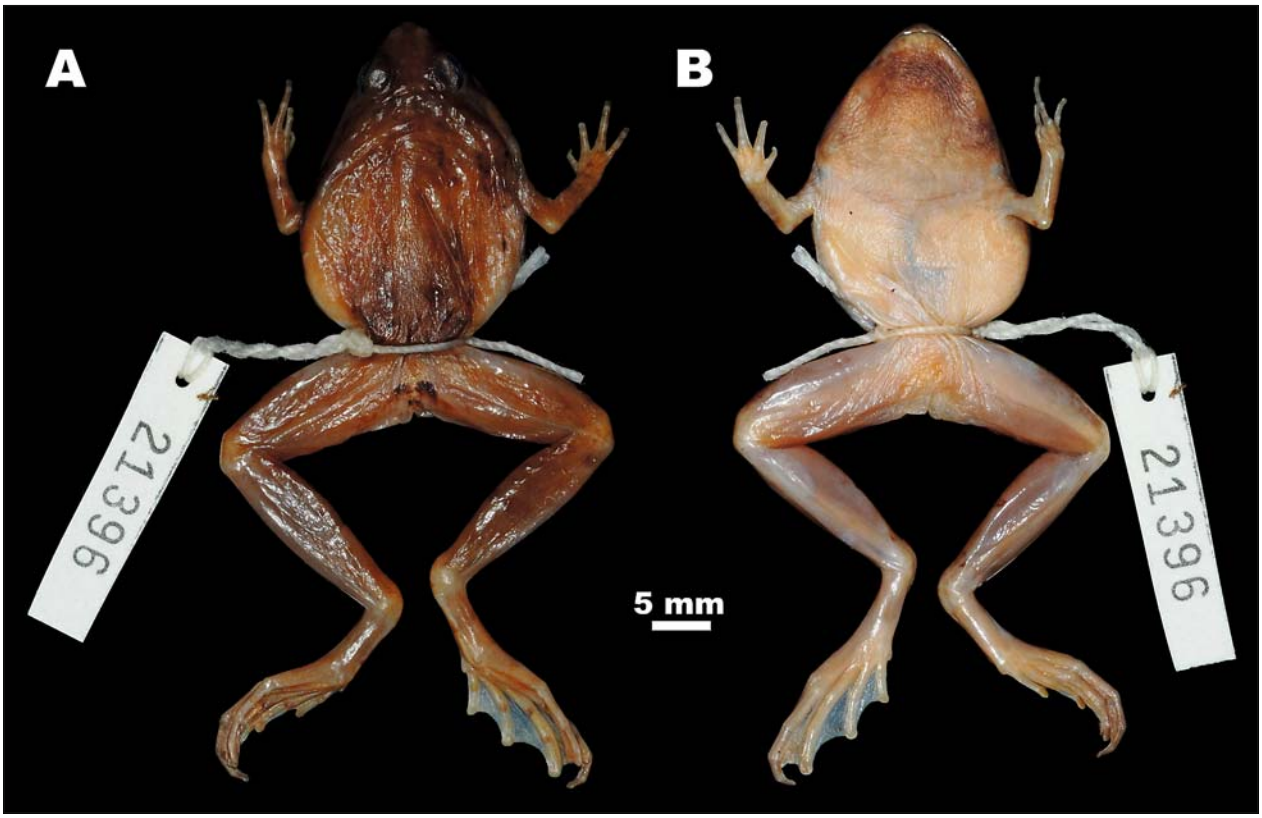

Fig. 29. Holotype of *Microhyla darevskii* sp. nov. (ZISP 7370, adult male) in preservative: (A) dorsal view; (B) ventral view. Photos by N. A. Poyarkov.

anterior, or posterior corners or ventrally from pupil; pupil round, black, outlined with a thin golden circle.

Coloration in preservative. In preservative the pattern described above almost disappears completely (Fig. 29), the color has almost completely faded, the dorsal background color turned to yellowish or beige, the dark dorsal pattern is almost not discernible, signs of dark markings can be traced as faded light-brown patterns; the characteristic paired spot above the cloacal opening is well seen. Limbs have a yellowish coloration, dark cross-bars on hindlimbs appear as indistinct tan patterns. Ventral surfaces turned light-beige, however, dark markings on chin are well notable as a brownish gray spotting. Inner surface of limbs lack dark spots or markings.

Variation. Individuals of the type series are generally very similar in appearance. The variation in size and body proportions is given in Table 1. Females of the new species are unknown to date; in males SVL varies 27.0 – 32.6 mm ($N = 5$); slit-like openings to a median subgular vocal sac are present in males. The male paratypes generally show a coloration pattern much more similar to that described for the holotype (see Fig. 31). The dorsal coloration varies from bronze to yellowish-brown. Certain variation in chin coloration is observed.

Tadpole description. Larvae and breeding biology of this species are yet unknown.

Natural history notes. All specimens were found while calling hiding in holes and shelters in soil or in the leaf litter in a distance of 1 – 5 m from a large temporary rain pool (Fig. 32), located on a meadow (pasture for local buffaloes) in a distance of about 30 – 50 m to the edge of primary evergreen montane tropical forest.

Breeding. Males were found under heavy rain around 22:00 – 23:00 on 15 of September.

Syntopic batrachofauna. In the environs of Mang Xang village *Microhyla darevskii* sp. nov. was found syntopically with *M. fissipes*, *M. butleri*, *M. heymonsi*. Other syntopic amphibian species include *Fejervarya limnocharis* (Gravenhorst, 1829), *Polypedates* cf. *megacephalus* Hallowell, 1861, *Kurixalus* cf. *banaensis* (Bourret, 1939), and *Duttaphrynus melanostictus* (Schneider, 1799).

Comparisons. Below we compare the new species *Microhyla darevskii* sp. nov. with all known congeners

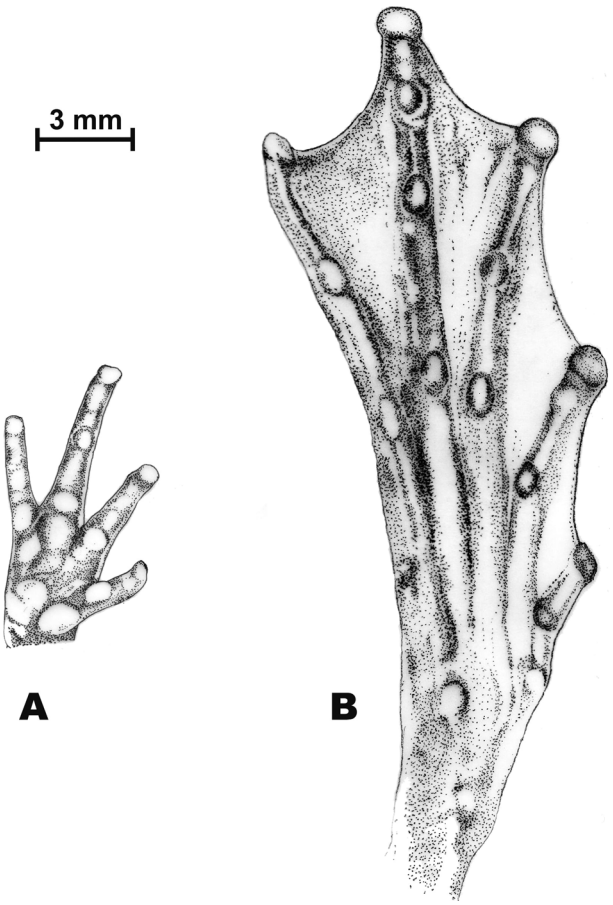

Fig. 30. Holotype of *Microhyla darevskii* sp. nov. (ZISP 7370, adult male): (A) palmar view of the right hand; (B) plantar view of the right foot. Drawings by V. D. Kretova.

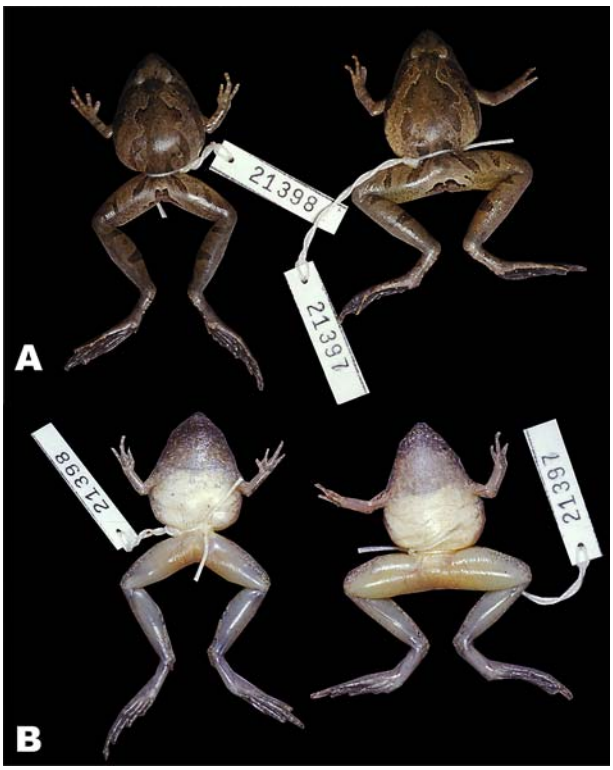

Fig. 31. Variation in coloration in the type series of *Microhyla darevskii* sp. nov. (ZMMU A-5050; adult males): (A) dorsal view; (B) ventral view. Photos by N. L. Orlov.

(morphological characters and distribution data for each species are summarized in Table 3).

A suite of external morphological features clearly differentiates *Microhyla darevskii* sp. nov. from all Indochinese and East Asian congeners. An important diagnostic character is the triangular and flattened body shape of this comparatively large (SVL 27.0 – 32.6) *Microhyla* species, not reported for other congeners of the same body size. The presence of a well developed foot webbing, reaching disks at all toes separates the new species from the following taxa, which show a basal webbing or a moderately developed webbing, not extending beyond distal subarticular tubercles: *M. butleri*, *M. fissipes*, *M. fusca*, *M. heymonsi*, *M. mixtura*, *M. okinavensis*, *M. picta*, *M. pulchra* (web does not reach beyond the distal tubercle of toe III), *Microhyla pineticola* sp. nov., *Microhyla minuta* sp. nov. The new species differs from *M. annamensis*, *M. berdmorei*, *M. butleri*, *M. heymonsi*, *M. marmorata*, *M. mixtura* (dorsal median grooves absent on finger disks, but distinct on toe disks), *M. nanapollexa*, *M. pulverata*, *Microhyla pineticola* sp. nov., *Microhyla pulchella* sp. nov., and *Microhyla minuta* sp. nov. by finger disks and median longitudinal grooves being totally absent, toe disks weak but with distinct dorsal longitudinal median grooves (vs. finger and toe disks well-developed, dorsal median longitudinal grooves usually present on all digits).

Among all other species of *Microhyla* found in Indochina and neighboring areas of Southeast Asia the new species is morphologically most similar to *M. berdmorei* and the closely allied *M. fowleri*. These two species are morphologically quite similar, sharing many morphological features; validity of *M. fowleri* was doubted by Matsui et al. (2011) based on the results of mtDNA phylogenetic analysis, however since no major revision of this complex was published, some authors still recognize it as valid (see Matsui, 2011; Frost, 2014), thus herein we refer to *M. fowleri* as a valid species. Assumingly *Microhyla darevskii* sp. nov. together with the latter species forms one complex, sharing such diagnostical characters as a well-developed toe webbing, reaching to disks at all fingers, pronounced toe disks, comparatively long hind-

Fig. 32. Breeding habitat of *Microhyla darevskii* sp. nov. in Mang Xang Village, environs of Ngoc Linh Mountain, Dac Choong Commune, Dac Glei District, Kon Tum Province, Vietnam. Photo by N. L. Orlov.

limbs with tibiotarsal articulation reaching well beyond the snout in adpressed limb, two metatarsal tubercles and the comparatively large body size (SVL 23.8 – 45.6). From both *M. berdmorei* (Fig. 2A) and *M. fowleri* the new species is different in its stocky, very flattened and somewhat triangular body habitus (vs. slender not triangular body habitus), in having a bluntly rounded snout in lateral view (vs. obtusely pointed snout in profile in *M. berdmorei* and *M. fowleri*), as well as in its dorsal coloration. In particular *Microhyla darevskii* sp. nov. lacks black irregular spots and blotches on body flanks and the inner surfaces of shanks, typical for *M. berdmorei*, and possesses a dark-brown trapezoid marking above the cloacal opening (vs. absent in *M. fowleri*). The new species is further differentiated from *M. berdmorei* in having a slightly tubercular or postulate dorsum (vs. smooth dorsum with occasional small tubercles), first finger being very well developed: finger I length is greater than a half of finger II length (vs. finger I length less than a half of finger II length in *M. berdmorei*), finger disks totally absent (vs. weak disks present on fingers in *M. berdmorei*), and a very broad foot webbing reaching the disks at all toes, formula I 1 – 1 II 1 – 1 III 1 – 1 IV 1 – 1 V (vs. web reaching to disks except toe IV in *M. berdmorei*, formula I 1 – 1 II 1 – 2 III 1 – 2 IV 2 – 1 V). Further differences of the new species from *M. berdmorei* include its ventral color and the iris coloration: groin area and ventral surface of tights bright-yellow in *M. berdmorei* (vs. no yellow color on groin and belly in the new species); the iris is golden with a black reticulation in *Microhyla darevskii* sp. nov. vs. copper iris with a distinct dark stripe ventrally in *M. berdmorei* (Fig. 2A); no dark stripe discernible in the new species. From *M. fowleri* the new species can be further differentiated by its coloration: presence of a clear cream stripe from the eye to mouth corner and a dark trapezoid mark above the cloacal opening (not distinct in *M. fowleri*), and by a broader foot webbing (webbing formula in *M. fowleri*: I 1 – 1 II 1 – 1 III 1 – 2 IV 2 – 1 V), pustules on dorsum irregularly scattered (vs. tubercles on dorsum organized in weak longitudinal rows in *M. fowleri*).

Microhyla darevskii sp. nov. can also be differentiated from other Southeast Asian and southern Asian congeners. Four miniature small-bodied species form the

Sundas and Malaya differ from *Microhyla darevskii* sp. nov. in having the first finger greatly reduced, present as a pronounced bulge or a free nub: *M. borneensis* (SVL 10.6 – 18.8), *M. perparva* (SVL 10.5 – 14.5), *M. petrigena* (SVL 13.9 – 17.8), and *M. palmipes* (SVL 16.8 – 21.0; first finger is a free nub). Basal foot webbing not extending beyond penultimate subarticular tubercles separate the following congeners from the new species: *M. achatina*, *M. borneensis*, *M. chakrapanii*, *M. maculifera*, *M. mukhlesuri*, *M. mymensinghensis*, *M. orientalis*, *M. ornata*, *M. rubra*. The latter species can be also easily distinguished by its stout habitus and an enlarged metatarsal tubercle. The presence of distinct finger disks separate the following taxa from the new species: *M. achatina*; *M. annectens*; *M. karunaratnei*; *M. malang*; *M. mantheyi*; *M. orientalis*; *M. sholigari*; *M. superciliaris*. *M. zeylanica* can be separated from the new species by much shorter legs, tibiotarsal articulation of adpressed limb reaches eye level (vs. heel adpressed limb reaches well beyond snout in *Microhyla darevskii* sp. nov.).

Distribution. To date the new species is known only from a single locality in the environs of Mang Xang Village, on the slopes of Ngoc Linh Mountain, central Annamite (Truong Son) Mountains, Kon Tum Province, Vietnam, at an elevation of about 1650 m a.s.l. Further studies of the distribution of this species are required. The discovery of new localities of *Microhyla darevskii* sp. nov. are anticipated in the neighboring province of Quang Nam (Vietnam) and, possibly, in adjacent parts of Laos. The extent of this species with regard to its population status needs to be studied in greater detail.

Etymology. The specific name "*darevskii*" is a latinized patronymic noun in genitive singular; the name of the new species is given in honor of Prof. Ilya S. Darevsky (1924 – 2009), to commemorate his great contribution to the studies of the Vietnamese herpetofauna, including the genus *Microhyla*: one of three species described by Bain and Nguyen (2004), *M. pulverata*, was described based on a series collected by I. S. Darevsky and N. L. Orlov in 1995.

Recommended vernacular name. The proposed common English name is Darevsky's (pigmy) narrow-mouth frog. The recommended common Vietnamese name is "Nhái bầu Da-rep-s-ki."

***Microhyla arboricola* sp. nov.**
Figs. 33 – 37

Holotype. ZMMU A-5051 (field number NAP-02700), adult male from the environs of Chu Pan Phan Mountain, Chu Yang Sin National Park, Khue Ngoc Dien Commune, Krong Bong District, Dak Lak Province, Vietnam (coordinates 12°23′42″ N 108°21′1.08″ E, elevation 1125 m a.s.l.) collected by N. A. Poyarkov and A. B. Vassilieva on 10 April 2012.

Paratypes. ZMMU A-4845 (field numbers ABV-00060, ABV-00062, ABV-00084, 3 adult males; and field numbers ABV-00061, ABV-00085, 2 adult females) collected from the same locality as the holotype by A. B. Vassilieva and E. A. Galoyan on 29 March and 4 April 2013; ZISP 11813 – 11814 (field numbers TAO-581, TAO-654, 2 adult males) from Chu Yang Sin National Park, Khue Ngoc Dien Commune, Krong Bong District, Dak Lak Province, Vietnam, coordinates 12°24′3.96″ N 108°21′15.84″ E, altitude ~1000 m a.s.l. , collected by Nikolai L. Orlov on 24 – 26 April 2009; ZMMU A-5052 (filed numbers ABV-00265, ABV-00267, ABV-00270, 3 adult males; field numbers ABV-00266, ABV-00268, 2 adult females) from Hon Ba Mt., Hon Ba Nature Reserve near Yersin Station, Khanh Hoa Province, Vietnam, coordinates 12°6′52.92″ N 108°56′36.96 E, elevation ~1550 m a.s.l., collected by A. B. Vassilieva on 13 – 15 June 2013.

Referred materials. Series of tadpoles ZMMU A-5076 (field number ABV-00257; 12 specimens; stages 25 – 39; description based on 8 specimens; stages 25 – 39), collected by A. B. Vassilieva on 14 June 2013 at Hon Ba Mt., Hon Ba Nature Reserve, Khanh Hoa Province, Vietnam.

Diagnosis. *Microhyla arboricola* sp. nov. is characterized by a combination of the following characters: 1) a small-sized form of *Microhyla*, body moderately slender; 2) SVL in adult males 13.2 – 15.0 mm, mean 14.11 mm; SVL in adult females 15.9 – 17.0 mm, mean 16.44 mm; 3) smooth dorsum, sometimes slightly tubercular at lateral sides of dorsum; 4) head triangular, snout pointed in profile; 5) finger I short, less than one-half the length of finger II; 6) tips of three outer fingers slightly dilated, forming expanded disks (less than twice the width of phalanges) with peripheral grooves, dorsally with weak median longitudinal groove; 7) tips of all toes distinctly dilated into disks (less than twice the width of phalanges) dorsally with median longitudinal groove producing the appearance of two scutes; 8) outer metacarpal tubercle single; single metatarsal tubercle, short and oval; 9) tibiotarsal articulation on adpressed limb reaching well beyond snout tip; 10) webbing basal, reaching penultimate tubercles: one and two thirds of phalanges at toe I, two and one fourth of phalanges at preaxial side of toe II, two phalanges at postaxial side of toe II, three phalanges on preaxial side of toe III, two and a half of phalanxes on postaxial side of toe III, three and a half of phalanges on preaxial side of toe IV, three phalanges on postaxial side of toe IV, one and a half of phalanges on toe V free of web; 11) eyelid without supraciliary

Fig. 33. Holotype of *Microhyla arboricola* sp. nov. (ZMMU A-5051, adult male) in life: (A) lateral view; (B) dorsal view. Photos by N. A. Poyarkov.

spines; 12) top of snout poorly differentiated from the gray-brown interorbital bar; short cream stripe from rear corner of eye to corner of mouth, bordered by dark-gray below; 13) vertebral stripe absent; 14) dark dorsal markings in a form of gray-brown figure constricted in the middle in a shape of hourglass; with two small black scapular spots, narrowly outlined in white; 15) a narrow, broken, series of black dorso-lateral spots continue from axilla to groin; 16) chin gray-brown, with small irregular mottling, belly and thighs with sparse brownish mottling; 17) reproduction takes place in water-filled tree holes; larvae with wide dorsally oriented mouth, upper labium edged with two large rounded protuberances, tail extremely long, more than three times longer than body.

Measurements of holotype (in mm). SVL 13.2; HL 4.4; SL 2.3; EL 1.8; N-EL 1.2; HW 5.6; IND 1.9; IOD 2.1; UEW 1.0; FLL 8.4; LAL 6.5; HAL 3.5; 1FL 0.6; IPTL 0.6; OPTL 0.6; 3FDD 0.6; HLL 23.9; TL 8.2; FL 7.0; IMTL 0.6; 1TOEL 1.1; 3TDD 0.7.

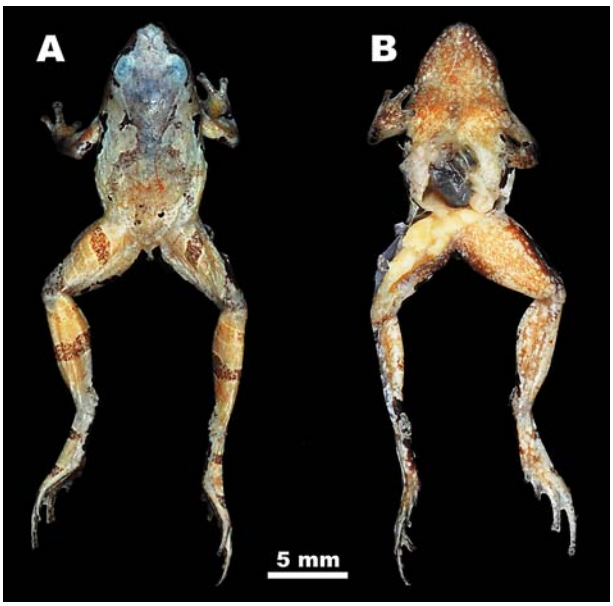

Fig. 34. Holotype of *Microhyla arboricola* sp. nov. (ZMMU A-5051, adult male) in preservative: (A) dorsal view; (B) ventral view. Photos by N. A. Poyarkov.

Description of holotype. Small-sized specimen, SVL 13.2 (all measurements in mm); habitus moderately slender, body elongated, triangular in shape (Figs. 33 and 34); head triangular, rounded, slightly wider (5.6) than long (4.4); snout comparatively long (2.3), triangular and pointed in dorsal view (Figs. 33B and 34A), notably pointed in profile (Fig. 33A), very slightly protruding beyond the margin of the lower jaw (Fig. 34B); eyes large, protuberant in lateral view, slightly protuberant in dorsal view, slightly shorter (1.8) than snout (2.3) (EL/SL 0.81) and just slightly shorter than the interoribtal distance (2.1) (EL/IOD 0.88). Top of head flat; canthus rostralis straight, clearly distinct, curved in dorsal view (Fig. 33B), running from anterior corner of eye to nostril and sharply curving ventrally anterior to nostril (Fig. 33A); loreal region vertical, notably concave; nostril round, lateral, well below canthus rostralis, somewhat closer to tip of snout (0.75) than to eye (1.2), interorbital distance narrow (2.1), almost equal to internarial distance (1.9) (IND/IOD 0.90), upper eyelid more than two times narrower (1.0) than interorbital distance (2.1) (UEW/IOD 0.46). Pineal spot absent; tympanum hidden; no signs of a supratympanic fold discernible (Fig. 33A). Choanae large, transverse oval-shaped, not widely spaced, largely concealed under margin of upper jaw; upper jaw edentate; vomerine teeth absent. Tongue without papillae or median notch, narrow and spatulate; free at the rear half of its length; slit-like openings to a median vocal sac.

Forelimbs short (8.4) and slender (Figs. 33, 34); lower arm comparatively long (6.5) and massive (LAL/FLL 0.78), hand (3.5) more than two times shorter than forelimb length (HAL/FLL 0.42). Fingers notably dorso-ventrally flattened, with wide skin fringes on fingers, which are well developed and reach finger disks in all fingers, fringes on postaxial side of first finger and preaxial side of second finger are especially well developed and form a rudimentary web reaching basis of disk at first finger and the level of posterior edge of proximal subarticular tubercle on second finger (Fig. 35A), rudimentary web is also present between second and third fingers, reaching the level of proximal subarticular tubercles; first finger greatly reduced (Fig. 35A), notably less than one-third the length of the second finger, second finger slightly shorter than fourth, latter much longer than first (0.6); relative finger lengths: I < II < IV < III; tip of first finger rounded, tips of three outer fingers notably dilated forming oval-shaped truncated disks of same width as basal phalange on third finger and slightly wider than basal phalanges on second and fourth fingers, diameter of first finger (0.6) is subequal to third finger disk (0.6); clear peripheral grooves well developed on all finger disks, narrow peripheral groove can be discernible on first finger tip, dorsally tips of three outer fingers with short poorly-developed but comparatively deep median longitudinal furrows, slightly notching finger disks but not producing appearance of two scutes, longitudinal furrows especially clearly seen at second and third finger disks, slightly discernible on fourth finger disk and absent on first finger tip; relative finger disk widths: I < IV≤ II = III; subarticular tubercles on fingers rounded and greatly flattened with indistinct edges, proximal subarticular tubercles distinct and comparatively prominent, distal subarticular tubercles on two outer fingers not very distinct: on third finger the distal subarticular tubercle is discernible, but no traces of distal subarticular tubercle can be seen on fourth finger, thus subarticular tubercle formula 1, 1, 2, 1; nuptial pad absent (Fig. 35A); two indistinct metacarpal tubercles: inner metacarpal tubercle oval-shaped; a single outer metacarpal tubercle (0.6) rounded and flattened with unclear edges, indistinct, subequal in diameter to the length of inner metacarpal tubercle (0.6).

Hindlimbs comparatively slender and long (23.9), little less than three times length of forelimb (HLL/FLL 2.9); tibia long and slender (8.2), around one-third of hindlimb length (TL/HLL 0.34), heels in contact when limbs are held at right angles to body (slightly overlapping for less than 1 mm); tibiotarsal articulation of adpressed limb reaching well beyond snout; foot (7.0) slightly shorter than tibia length (HLL/FL 0.3; TL/FL

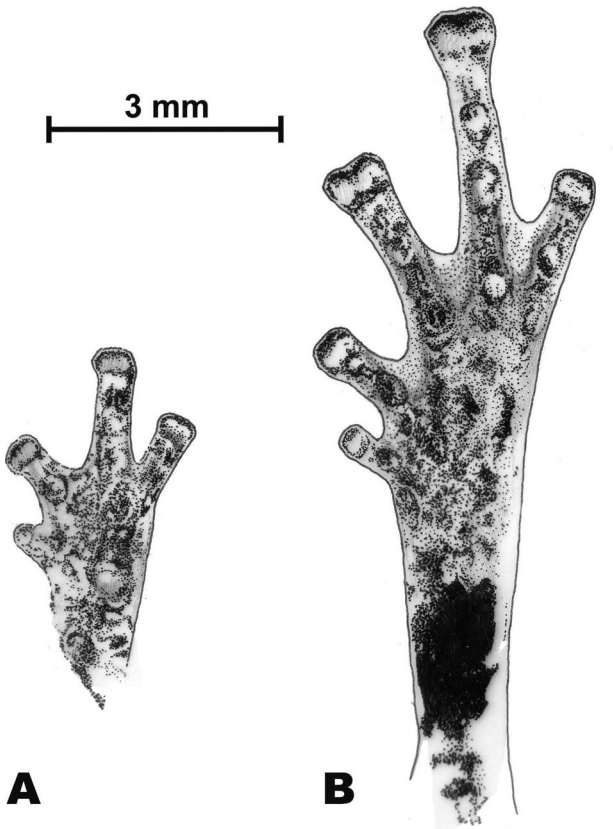

Fig. 35. Holotype of *Microhyla arboricola* sp. nov. (ZMMU A-5051, adult male): (A) palmar view of the left hand; (B) plantar view of the left foot. Drawings by V. D. Kretova.

1.16). Relative toe lengths: I < II < V < III < IV; tarsus smooth, inner tarsal fold absent; tips of all five toes distinctly dilated into wide truncated disks, wider than those of fingers (disk diameter of third toe 0.8; 3FDD/3TDD 0.9), disks of all toes with well-developed peripheral grooves, dorsally all toe disks with short median longitudinal grooves, similar to those at finger disks but more prominent and well-developed; relative toe disk widths: I < V < II < III = IV; third toe much longer than fifth. Toes distinctly flattened dorso-ventrally, with narrow fringes on preaxial and postaxial sides of four outer toes reaching to disks. Webbing between toes comparatively well developed reaching the level of penultimate subarticular tubercles, at all toes web reaches disk as fringe (Fig. 35B), webbing formula (number of phalanges free of web): I $1^2/_3$ – 2¼ II 2 – 3 III 2½ – 3½ IV 3 – 1½ V; subarticular tubercles on toes round, flattened and very indistinct, formula 1, 1, 2, 3, 2, proximal subarticular tubercles at all toes are distinct, but distal tubercles have unclear edges and are less prominent, not very distinct; metatarsal tubercle single: inner metatarsal tubercle

small, short, bean-shaped, prominent, length (0.6) is slightly more than half of first toe (1.1); outer metatarsal tubercle totally absent.

Dorsal skin feebly granular above (Figs. 33 and 34A), with few small round low tubercles and granules scattered over dorsum, a pair of notably larger elongated granules located on scapular region, surrounded by smaller tubercles; two oblique rows of small glandiform granules runs from posterior corner of eye toward larger granules in scapular area (see Fig. 33B), length of glandular rows is greater than eye diameter, small granules are scattered over dorsal surfaces of forelimbs, including lower arm; dorsal surfaces of hindlimbs covered by irregularly scattered low tubercles and pustules, granules on hindlimbs larger than those on forelimbs; dorsolateral edges not clearly distinct with occasional granules on them; dorsolateral edges gradually flatting posteriorly; eyelid without supraciliary spines or granules; flanks of body and lateral sides of head smooth, with small granules present only in tympanal area and axilla; ventral side of body and limbs smooth (Fig. 34B), vent smooth. Cloacal opening unmodified, directed posteriorly, at upper level of thighs.

Coloration in life. Dorsal coloration in life pinkish-beige to light yellow-brown in anterior part of dorsum and head, getting somewhat darker posteriorly and turning light ochre in posterior part of dorsum; dorsal surfaces of forelimbs light orange-brownish, dorsal surfaces of hindlimbs slightly darker and have tan-brownish coloration (Fig. 33A, B). Dorsal surfaces with distinct dark pattern: forehead and snout lighter and have no spots or dark markings, an indistinct light-brownish interorbital bar runs transversally across the head between the most medial parts of upper eyelids, covering posterior fourth of eyelids, pineal area without dark markings and has same light coloration as the forehead; interorbital bar forms very indistinct broad V-shaped figure across the head running posteriorly till scapular area; this figure is edged with two light-colored beige narrow lines, which mark characteristic glandular rows running from posterior edges of eyes towards scapular area, these light-colored glandular rows are well-discernible both in life (Fig. 33A, B) and in preservative (Fig. 34A). Interorbital bar and head basis covered with irregular darker (brownish or tan colored) marbling not forming and clear distinct pattern. The dorsal marking becomes much darker — brownish or ochre-brownish — and more distinct posterior from head basis where it narrows forming a deep waist at scapular area (minimal width of dark mark comparable to width of upper eyelid, UEW) and runs posteriorly sharply widens forming a shape of hourglass or X-shape (the waist of this figure is located in scapular area, upper part reaches eyelids and lower part lasts till groin area), the dark dorsal marking is edged with thin cream-beige line. Posterior from scapular narrowing of the X-shaped dark dorsal marking two distinct dark bands gently curving run towards groin area, where they become indistinct. When the frog is sitting it looks like these dark markings continue to thighs and shanks (Fig. 33B). On both sides of dorsum in scapular region two small distinct brown-black oval-shaped spots are located laterally from the anterior part of X-shaped dark dorsal marking; the left spot is larger and merges with X-shaped figure. These dark spots mark two prominent pinkish warts, similar pinkish tubercles and pustules can be seen on posterior part of dorsum. No medial round black spot or vertebral stripe present on dorsomedial line. Two small black ocelli accompanied by two black spots located on sacrum along the coccyx (Fig. 33B). Left upper eyelid with a tiny black spot on the periphery.

Flanks and head sides slightly darker than the dorsum, having brownish background coloration: dark-ochre to dark-brown on upper jaw, gray-brownish on body flanks; no distinct dark lateral stripe present. A distinct brown-black stripe curves from snout tip towards nostril and then runs posteriorly along canthus rostralis towards anterior edge of eye; stripe has irregular borders and distinctly widens closer to eye (Fig. 33A). On the posterior edge of eye an irregular shaped black triangular blotch is present; the supratympanic area without dark line, on both sides of head a small black spot located on a middle of distance between eye and axilla. From the area above axilla an interrupted dark stripe runs posteriorly along dorsolateral edge, it reaches groin and sharply ends ~1.0 mm anterior to hindlimb insertion. On both body sides a black large triangular blotch is located above limb insertion and a black stripe runs from the area above axilla to groin, slightly widening posteriorly; both black marks edged with thin cream-white line. Brownish coloration of body flanks continues ventrally turning somewhat lighter at belly; a small rounded black spot edged with white is located on flanks posterior to axilla on each body side. Upper jaw with irregular whitish mottling and larger cream-white spots along the edge of maxilla (Fig. 33A). A row of three narrow cream-yellow spots runs from posterior corner of eye ventrally and then posteriorly towards to mouth angle, larger spot located closer to eye, two smaller spots at mouth angle. Tympanal and axillar area covered by whitish mottling. Body flanks posterior to hindlimb insertion with small bluish or whitish spots (Fig. 33A). Limbs dorsally with indistinct brownish marbling pattern: on fore arm and lower arm irregular brownish blotches, on thigh and shank distinct brown cross-bars edged with thin cream-white lines: three bars on each of thighs and knees and two bars on shanks, cross-bars have comparatively

straight borders and when in sitting frog forms an image of continuous dark stripes lasting from scapular area to shanks (Fig. 33B). Characteristic black spots on posterior surface of fore arm proximal than the elbow, larger black spots on anterior surface of thighs over knee area; characteristic double (in dorsal view) black spots on posterior edges of shanks (Fig. 33B). Fingers and toes dorsally with indistinct brownish mottling.

Ventral surfaces grayish-beige on belly to reddish-brown on throat with numerous small cream-yellow or whitish spots and mottling scattered across chest and central parts of belly (Fig. 34B); chin notably darker, with dark brownish color being more abundant on throat margins; no light medial line on chin. Vent pinkish-beige; limbs ventrally brownish mottling; at ventral surfaces of hand and fingers (Fig. 35A) irregular dark mottling, on ventral surfaces of hindlimb a distinct characteristic large black spot on tibiotarsus and irregular brownish markings on foot and toes (Fig. 35B), which continues to ventral surfaces of fingers and toes. Iris dark copper with dense black reticulation; pupil round, black, outlined with thin copper-orange circle (Fig. 33A).

Coloration in preservative. In preservative the pattern described above does not change obviously, however colors significantly faded; dorsal background color looks gray-beige (Fig. 34). Yellowish and reddish tints fade the most, X-shaped dark dorsal marking is clearly seen and has grayish color, anterior part dorsum and dorsal surfaces of head became bluish-gray, dark cross-bars on limbs became gray-brownish (Fig. 34A); ventral sides look much lighter than in life (Fig. 34B); with red color totally disappeared in preservative belly looks cream-yellowish with irregular brownish spotting.

Variation and sexual dimorphism. Individuals of the type series are generally quite similar in appearance, but show certain variation in coloration. Variation in size and body proportions is given in Table 1. Males are much smaller than females and all have SVL under 15.0 mm, whereas all studied females had SVL over 15.9 mm: SVL 13.2 – 15.0 mm in males ($N = 9$) and 15.9 – 17.0 mm in females ($N = 4$). Males possess medial gular pouches. Specimens from Hon Ba, Khanh Hoa Province, are very similar in coloration and external morphology to specimens from Chu Yang Sin National Park, Dak Lak Province. Males often have somewhat lighter coloration than females, with dark X-shaped dorsal pattern being less prominent and lighter, and dark lateral stripes are greatly reduced to a discontinuous line of irregular black spots (Fig. 36A). In females, dorsal coloration often is somewhat darker, forehead is much lighter than dorsum, interorbital bar distinct brownish-red, X-shaped pattern wider and more resembles hourglass than X-shape, it has irregular borders and is edged with white line; dark dorsolateral stripe wider and runs from axilla to groin along dorsolateral edges, body sides and ventral surfaces have also darker reddish-brown coloration, and white stripe from eye to mouth angle is more distinct (Fig. 36B). No significant variation in diagnostic characters within the type series of the new species was found, and all specimens are easily diagnosable.

Fig. 36. Paratypes of *Microhyla arboricola* sp. nov. in life: (A) adult male from Hon Ba Mt., Hon Ba Nature Reserve, Khanh Hoa Province, Vietnam, dorsolateral view; (B) adult female from Hon Ba Mt., Hon Ba Nature Reserve, Khanh Hoa Province, Vietnam, dorsolateral view. Photos by V. L. Trounov.

Brief tadpole description. Tadpoles develop in water-filled tree holes and have a very specific morphology, not similar to that of any other larvae of *Microhyla* species from Indochina or Eastern Asia (Fig. 37). Body elliptical or pyriform, with a depressed, bluntly rounded snout. Eyes dorsal, not visible from below. Tail extremely long (more than three times longer than body), with developed muscular part and low fins. Spiracle ventral, medial, slit-like, without free dermal flap. Oral disk wide, oriented dorsally, upper labium edged with two large rounded protuberances; oral funnel and keratinized ele-

Fig. 37. Tadpoles of *Microhyla arboricola* sp. nov. in life, dorsolateral view: (A) stage 39; (B) at metamorphosis, stage 43. Not to scale. Photos by V. L. Trounov.

ments absent. Live coloration uniformly dark brown or gray, with tail fin and belly being slightly paler.

Larvae of the new species are superficially similar in body shape and coloration to the tadpoles of the phytotelm breeding rhacophorid *R. vampyrus*, but clearly differ from them by mouth morphology and spiracle position (for description of *R. vampyrus* see Rowley et al., 2012a; Vassilieva et al., 2013a). The detailed description of tadpole morphology and peculiarities of *M. arboricola* sp. nov. reproductive biology will be published elsewhere.

Natural history notes. In Chu Yang Sin National Park (the type locality), the new species was found in a water-filled tree hollows in a montane high evergreen tropical forest with the predominance of Fagaceae (*Lithocarpus*, *Castanopsis*) on the slope of Chu Pan Phan Mt. at elevations ~1000 m a.s.l. In Hon Ba Nature Reserve specimens were collected in tree hollows (see Fig. 38B) on the limited grove of primary montane polydominant evergreen forest on the top of mountain ridge at elevation ~1500 m a.s.l., with the predominance of Fagaceae (*Lithocarpus*, *Quercus*), Elaeocarpaceae (*Elaeocarpus*), Theaceae, Lauraceae, Araliaceae, and Rutaceae, and abundance of large granite rocks (Fig. 38A).

Breeding. The start of reproduction was observed in Chu Yang Sin National Park in the end of March after a series of heavy rains at temperature ~15 – 16°C at night and 20 – 23°C at day time; in Hon Ba Nature Reserve the breeding was recorded in the middle of June during the rainy season at temperature ~18 – 20°C at night with little diurnal change. The new species is an obligate phytotelm breeder depositing the clutches in the water-filled tree hollows. Clutches comprising up to 30 large pigmented eggs are suspended on hollow walls above the water level (Fig. 38); hatching tadpoles drop to the water where they develop until metamorphosis.

Fig. 38. Natural habitat of *Microhyla arboricola* sp. nov. in a mixed evergreen montane tropical forest, Hon Ba Mt., Hon Ba Nature Reserve, Khanh Hoa Province, Vietnam: (A) natural habitat of the new species; (B) breeding place in a water-filled tree hollow, white arrow indicates egg mass attached to the tree; (C) egg clutches of the new species attached above water in a water-filled tree hollow. Photos by A. B. Vassilieva and V. L. Trounov.

Syntopic batrachofauna. In Chu Yang Sin National Park *Microhyla arboricola* sp. nov. occurs syntopically with *Theloderma chuyangsinense* Orlov, Poyarkov, Vassilieva, Ananjeva, Nguyen, Nguyen et Geissler, 2012 and *M. annamensis*. In Hon Ba Nature Reserve *Microhyla arboricola* sp. nov. occurs syntopically with *Kalophrynus honbaensis* Vassilieva, Galoyan, Gogoleva et Poyarkov, 2014, *R. gryllus*, *H. montivaga*, *L. leucops*, and *I. galeatus*. In Hon Ba Nature Reserve the new species were observed to share breeding sites with other obligate hollow breeders, *R. vampyrus* and *Theloderma* cf. *truongsonense* (Orlov et Ho, 2005).

Comparisons. The new species *Microhyla arboricola* sp. nov. is compared below with all known congeners (morphological characters and distribution data for each species are summarized in Table 3).

The new species can be easily differentiated from all other *Microhyla* species known to date for the territory of Vietnam. SVL in males of *Microhyla arboricola* sp. nov. does not exceed 15.0 mm and varies around 14.1 mm (SVL 13.2 – 15.0 mm); females of the new species, though larger than males, are also very small with mean SVL 16.4 mm (SVL 15.9 – 17.0 mm), thus the new species *Microhyla arboricola* sp. nov. is even smaller than the diminutive *Microhyla minuta* sp. nov. described above. The other miniature *Microhyla* species of the Vietnamese fauna — *M. nanapollexa* is known only from a single female specimen with SVL 16.6 mm, however the variation in body size of this species is yet unknown. Thus the new species *Microhyla arboricola* sp. nov. is the smallest frog and possibly the smallest tetrapod known to date for the fauna of Vietnam. It is noteworthy that the smallest *Microhyla* species (*M. borneensis*) from Borneo is also a phytotelm breeder and reproduces in water-filled pitcher plants (*Nepenthes* ssp.) (Das and Haas, 2010; Matsui, 2011).

A set of morphological characters separates *Microhyla arboricola* sp. nov. from all of its Indochinese and East Asian congeners. The presence of well developed digital disks, present on three outer fingers and all toes in *Microhyla arboricola* sp. nov. differentiates this taxon from *Microhyla* species with digit tips not expanded to disks or species in which disks are restricted to toes: *M. fissipes*, *M. fowleri*, *M. okinavensis*, *M. pulchra*, and *M. picta*, the latter species is further different in stout body habitus and enlarged outer metatarsal tubercle. The presence of one metatarsal tubercle in *Microhyla arboricola* sp. nov. differentiates the new species from all other Indochinese and East Asian congeners (all having two metatarsal tubercles) but *M. nanapollexa* (one metatarsal tubercle), but the latter species can be further easily differentiated from *Microhyla arboricola* sp. nov. in having a broad foot webbing reaching the toe disks (vs. basal webbing reaching penultimate subarticular tubercles in *Microhyla arboricola* sp. nov.). The presence of a basal foot webbing, reaching the level of the penultimate tubercles in *Microhyla arboricola* sp. nov. also separates this taxon from a set of Indochinese *Microhyla* species: *M. annamensis*, *M. berdmorei*, *M. fowleri*, *M. marmorata*, *M. pulverata*, *Microhyla pulchella* sp. nov., and *Microhyla darevskii* sp. nov. The other *Microhyla* species known from Indochina and East Asia can be easily differentiated from the new species in having comparatively short legs with the subarticular articulation of an adpressed hindlimb not protruding beyond the snout (vs. subarticular articulation of adpressed limb reaching well beyond snout in *Microhyla arboricola* sp. nov.): *M. butleri*, *M. fusca*, *M. heymonsi*, *M. mixtura*, *M. okinavensis*, *M. picta*, *Microhyla pineticola* sp. nov., and *Microhyla minuta* sp. nov.

Microhyla arboricola sp. nov. can also be also differentiated from other Southeast Asian and South Asian congeners. Three miniature species form the Sundas differ from *Microhyla arboricola* sp. nov. in having the first finger greatly reduced, present as a pronounced bulge: *M. borneensis* (SVL 10.6 – 18.8), *M. perparva* (SVL 10.5 – 14.5), and *M. petrigena* (SVL 13.9 – 17.8); the other small-sized species from Malayan peninsula and Sundas — *M. palmipes* (SVL 16.0 – 21.8) can be differentiated from the new species by its first finger being present only as a small free nub, the lack of dorsal median longitudinal grooves of digital disks and the presence of two metatarsal tubercles (vs. first finger slightly reduced, somewhat less than a half of the second finger, dorsal median grooves on digit disks present, single metatarsal tubercle in *Microhyla arboricola* sp. nov.). *M. palmipes* and *M. superciliaris* can be further separated from the new species by the presence of supraciliary tubercles on the upper eyelid (vs. supraciliary tubercles absent in *Microhyla arboricola* sp. nov.). A number of *Microhyla* species are distinguishable from *Microhyla arboricola* sp. nov. by having comparatively short hindlimbs with tibiotarsal articulation of the adpressed leg not protruding well beyond the snout (vs. long hindlimbs with heel of adpressed limb protruding well beyond snout in *Microhyla arboricola* sp. nov.): *M. achatina*, *M. borneensis*, *M. maculifera*, *M. malang*, *M. mukhlesuri*, *M. mymensinghensis*, *M. orientalis*, *M. ornata*, *M. palmipes*, *M. rubra*, *M. sholigari*, *M. superciliaris*, and *M. zeylanica*. A number of South and Southeast Asian species can be easily separated from *Microhyla arboricola* sp. nov. in having a well-developed broad foot webbing, reaching to toe disks or at least to the level of distal subarticular tubercles (vs. basal webbing, to the level of proximal subarticular tubercles in the new species): *M. annectens*, *M. karunaratnei*, *M. malang*, *M. mantheyi*, *M. palmipes*, *M. perparva*, *M. petrigena*, *M. superciliaris*, and *M. zeylanica*. Finally, *M. chakrapanii*, a species found on the Andaman Islands, can be easily separated from the new species by having two metatarsal tubercles, the absence of disks on fingers and absence of median longitudinal grooves on digit tips both on fingers and toes (vs. one metatarsal tubercle, disks and dorsal longitudinal grooves present both on fingers and toes in *Microhyla arboricola* sp. nov.).

Distribution. The known distribution of *Microhyla arboricola* sp. nov. is shown in Fig. 1. The species was recorded in montane evergreen forests at elevations 800 – 1500 m, in Dak Lak and Khanh Hoa provinces, Vietnam. The new species is considered to be endemic to the southern part of the Annamite Mountains in southern

Vietnam. The extent of the new species distribution in Vietnam and its population status are not known, but new records in other areas of the southern Annamites are anticipated; The occurrence of *Microhyla arboricola* sp. nov. in Lam Dong Province is highly probable. Because of the small range in Vietnam, restricted to mountainous areas, the species is vulnerable because of habitat loss due to increased logging, destruction of forests and other anthropogenic activities in the area of its distribution. The species is protected in the Chu Yang Sin National Park and Hon Ba Nature Reserve.

Etymology. Latin for "inhabitant of trees," used as a noun in apposition; from Latin "*arbor*," "tree," which the new species uses for reproduction.

Recommended vernacular name. The recommended common English name is Tree-dwelling (pigmy) narrow-mouth frog. The recommended common name in Vietnamese is "Nhái bầu cây."

DISCUSSION

Systematic and phylogenetic remarks. Views on evolutionary relationships within the genus *Microhyla* have been controversial. Parker's (1934) monograph on the Microhylidae includes 15 Asian and 11 American species in the genus *Microhyla*, he also recognized two major groups (I and II) that differ in snout length. Group I encompassed three subgroups (A-C) whereat most Asian species were included into subgroups A and B, while short-snouted *Microhyla inornata* Boulenger, 1890, and American members were grouped in C. Later Carvalho (1954) withdrew the American species from the genus *Microhyla*, thus confining its distribution to Asia. Dubois (1987) used Parker's the identification key (1934) and classified unnamed groups proposed by the latter author. He recognized a distinct Asian genus *Micryletta* for *M. inornata* (group IC of Parker, 1934), distinguishing it from *Microhyla* on the basis of a set of characters, including the following: snout shorter than the eye and eye quite prominent, distinct tympanum, digit tips not expanded to disks, foot webbing totally absent and first finger not highly reduced (opposite conditions found in most species of *Microhyla*).

Dubois (1987) also split the genus *Microhyla* in two subgenera, *Microhyla sensu stricto* (corresponds to the group IA of Parker, 1934) and *Diplopelma* (group IB of Parker, 1934), distinguishable mostly by the presence of terminal digital disks with median longitudinal grooves (present in *Microhyla*, absent in *Diplopelma*); thus the subgenus *Diplopelma* included the following species: *Microhyla okinavensis* Stejneger, 1901, *Microhyla ornata* (Duméril et Bibron, 1841) s. lato, *Microhyla picta* Schenkel, 1901, *Microhyla pulchra* (Hallowell, 1861) and *Microhyla rubra* (Jerdon, 1854). The species *Microhyla fissipes* Boulenger, 1884, resurrected from *M. ornata sensu lato* by Matsui et al. (2005), *Microhyla mukhlesuri* Hasan, Islam, Kuramoto, Kurabayashi et Sumida, 2014, and *Microhyla mymensinghensis* Hasan, Islam, Kuramoto, Kurabayashi et Sumida, 2014, split from *M. ornata sensu lato* by Hasan et al., 2014, can be placed in this subgenus by implication.

Dubois (1987) further recognized two species groups in the subgenus *Microhyla* s. str.: the *berdmorei* group (IA1 group of Parker, 1934) and the *achatina* (IA2 group of Parker, 1934) group. In the *berdmorei* group, foot webbing is extensive, the palatines are present and digital disks are well-developed; the group includes *Microhyla annamensis* Smith, 1923, *Microhyla annectens* Boulenger, 1900, *Microhyla berdmorei* (Blyth, 1856), *Microhyla borneensis* Parker, 1928, *Microhyla* butleri Boulenger, 1900, *Microhyla fowleri* Taylor, 1934, *Microhyla mixtura* Liu et Hu, 1966, *Microhyla palmipes* Boulenger, 1897, *Microhyla perparva* Inger et Frogner, 1979, *Microhyla petrigena* Inger et Frogner, 1979, and *Microhyla superciliaris* Parker, 1928. Also, *Microhyla mantheyi* Das, Yaakob, et Sukumaran, 2007, *Microhyla malang* Matsui, 2011 and, *Microhyla orientalis* Matsui, Hamidy et Eto, 2013 can be included in this group by implication on the basis of phylogenetic analyses (Das et al., 2007, Matsui, 2011, Matsui et al., 2011, 2013). In the *achatina* group, foot webbing is reduced, the palatines are absent and the digital disks are comparatively small; the group comprises *Microhyla achatina* Tschudi, 1838, *Microhyla chakrapanii* Pillai, 1977, *Microhyla fusca* Andersson, 1942, *Microhyla heymonsi* Vogt, 1911, and *Microhyla zeylanica* Parker et Osman-Hill, 1949. Taxonomic placement of the following species remained undetermined, since they were described after Dubois (1987): *Microhyla erythropoda* Tarkhnishvili, 1994, *Microhyla karunaratnei* Fernando et Siriwardhane, 1996, *Microhyla maculifera* Inger, 1989, *Microhyla marmorata* Bain et Nguyen, 2004, *Microhyla nanapollexa* Bain et Nguyen, 2004, *Microhyla pulverata* Bain et Nguyen, 2004, and *Microhyla sholigari* Dutta et Ray, 2000.

Fei et al. (2005, 2009) reviewed the Chinese species of *Microhyla* and proposed an alternative classification, not recognizing subgenera, but splitting *Microhyla* into two species groups based on characters of their digital morphology: *butleri* group (encompasses *M. fowleri*, *M. mixtura*, *M. butleri* and *M. heymonsi*) and *ornata* group (contains *M. ornata* (= *M. fissipes*) and *M. pulchra*).

Recently, Matsui et al. (2011) provided an extensive phylogeny of Asian microhylids on the basis of 12S rRNA and 16S rRNA mtDNA data and confirmed the validity of the genus *Micryletta*, also supported by Pyron

and Wiens (2011), and suggested that the genus *Microhyla* may be paraphyletic, with a clade composed of genera *Calluella* and *Glyphoglossus* embedded within it. Preliminary phylogenetic results of Matsui et al. (2011) support neither the artificial classification of Dubois (1987) entirely based on interpretation of Parkers' (1934) diagnostic key nor the classification of Fei et al. (2005). They propose to split the genus *Microhyla* into the subgenus *Microhyla* s. str. (subclade AI of Parker, 1934) and an unnamed subgenus (subclade AIII, including *M. annectens*, *M. perparva*, *M. petrigena*, and *M. marmorata*). Within the newly defined subgenus *Microhyla* s. str. they recognize four species groups: the *palmipes* group (AIa; *M. palmipes*), the *ornata* group (AIb; *M. ornata*, *M. rubra*), the *butleri* group (AIc; *M. butleri*, *M. superciliaris*), and the *achatina* group (AId; *M. achatina*, *M. berdmorei*, *M. borneensis*, *M. orientalis*, *M. pulchra*, *M. fissipes*, *M. heymonsi*, *M. okinavensis*, *M. mixtura*, *M. mantheyi*, *M. malang*, and two yet undescribed species).

Thus, taxonomy of the genus *Microhyla* is quite complicated due to the high frequency of morphological homoplasies and discordance between molecular phylogenies and morphological data. Taxonomic studies in *Microhyla* are also hampered by superficial similarities and widespread misidentifications of these frogs. Many taxonomic descriptions made in the last century or earlier are brief and insufficient complicating species identification, leading to taxonomic confusion, and resulting in certain species being misidentified for decades; examples include *M. ornata — M. fissipes* complex (see Matsui et al., 2005); *M. annamensis* and allied taxa (see Bain and Nguyen, 2004); *M. borneensis* and allied taxa (see Das et al., 2007; Das and Haas, 2010; Matsui, 2011).

In the present paper we do not compare the taxa in questions with species of the genus *Micryletta* Dubois, 1987: *Micryletta inornata* (Boulenger, 1890), *Micryletta stejnegeri* (Boulenger, 1909), and *Micryletta erythropoda* (Tarkhnishvili, 1994). The latter species is currently recognized as a member of the genus *Microhyla* Tschudi, 1838 (Frost, 2014; AmphibiaWeb, 2014; Nguyen et al., 2009); however, as unsubstantially proposed by Orlov et al. (2002), this species actually belongs to *Micryletta* Dubois, 1987. The availability of type material examined and the personal communication of D. N. Tarkhnishvili (2008) convince us of the correctness of the taxonomic allocation by Orlov et al. (2002) which we follow herein. All members of the genus *Micryletta* are easily diagnosable from *Microhyla* (see Dubois, 1987, Manthey and Grossman, 1997).

Preliminary Taxonomic Assignment of the New Species Described Above

***Microhyla pineticola* sp. nov.** The phylogenetic position of *Microhyla pineticola* sp. nov. is yet unknown and requires further studies. On the basis of external morphology of adults and larvae we tentatively regard this new species as a member of *M. heymonsi* species complex (member of the subclade AId2, *M. achatina* group of Matsui et al., 2011), these two species are quite similar morphologically. Morphological characters allow us to assign the new species to the *M. achatina* group (IA2 group of Parker, 1934, subgenus *Microhyla* s. str. of Dubois, 1987) by implication; however further studies are needed to determine phylogenetic position of the new species since molecular phylogeny of the genus *Microhyla* does not support morphological classifications of Parker, 1934, Dubois, 1987 and Fei et al., 2009 (see Matsui et al., 2011).

***Microhyla pulchella* sp. nov.** The phylogenetic position of *Microhyla pulchella* sp. nov. is unstudied and a phylogenetic examination of the new species of the genus *Microhyla* is required. In their preliminary phylogeny Matsui et al. (2011) assumed paraphyly of the genus *Microhyla* in respect to the genera *Calluella* and *Glyphoglossus*, which is divided in two major clades AII (*M. marmorata*, *M. petrigena*, *M. perparva*, *M. annectens*) and AI (all other species in the analysis). Based on the preliminary evidence of external morphological data we assume that *Microhyla pulchella* sp. nov. seems to be a close relative of *M. marmorata* and *M. pulverata*, and these three species are quite similar morphologically. Thus from morphological viewpoint tentatively we assume that these taxa form a species complex which belongs to *M. annectens* species group of Matsui et al. (2011) by implication, however molecular phylogenetic data are needed to prove this assumption.

***Microhyla minuta* sp. nov.** The phylogenetic position of *Microhyla minuta* sp. nov. is yet unknown and requires further studies. From preliminary data of external morphology, among other congeners from Southern and Southeast Asia *Microhyla minuta* sp. nov. appears to be most similar to two small-bodied species from Sundas — *M. palmipes* known from Malaya and Greater Sundas (*M. palmipes* group — AIa of Matsui et al., 2011), and a recently described *M. orientalis* from Bali (*M. achatina* group — AId of Matsui et al., 2011) (for comparisons with these species see above). Morphological similarity to the original description of *M. palmipes* by Boulenger (1897) and Parker's (1934) description of this species possibly caused its tentative identification as "*Microhyla* aff. *palmipes*" by Tarkhnishvili (1994; 1995) in his pioneer works on amphibian communities of lowland tropi-

cal forests of southern Vietnam. Bain and Nguyen (2004) reviewed Vietnamese *Microhyla* and indicated that the specimen described by Tarkhnishvili warrants further study, "since it may represent another record of *M. nanapollexa*, or perhaps a previously undescribed species." Bain and Nguyen (2004) also reviewed other records of *M. palmipes* for Vietnam, considered them to be unjustified and removed this species from the herpetofaunal list of Vietnam. In the present paper, we rediscover the *Microhyla* reported by Tarkhnishvili (1994; 1995) and show that it represents a previously undescribed species. However, evolutionary relationships of the new species to *M. palmipes* and allied taxa need to be tested using methods of molecular phylogenetic analyses.

***Microhyla darevskii* sp. nov.** The phylogenetic relationships of *Microhyla darevskii* sp. nov. to its congeners are unstudied and need to be tested using methods of molecular phylogenetic analysis. External morphology of this species assumes affinities with two other large-bodied *Microhyla* with broad foot webbing from Indochina and adjacent territories: *M. berdmorei* and *M. fowleri* (all belong to *M. achatina* group (AId) of Matsui et al., 2011). However, some concerns on the validity of *M. fowleri* have risen after publication of Microhylidae phylogeny by Matsui et al. (2011), where samples from northern Thailand identified as *M. fowleri* grouped in one clade with *M. berdmorei* with minimal *p*-distance of 3.9 – 4.4%. *M. fowleri* was originally described from Chiang Mai, Siam (now Thailand, see Taylor, 1934), but was later synonymized with *M. berdmorei* by the author himself, possibly it was described from subadult specimen of *M. berdmorei*. However, some authors still consider *M. fowleri* as a valid species (Dubois, 1987; Yang and Rao, 2008; Fei et al., 2009, Frost, 2014). Evolutionary relationships of *Microhyla darevskii* sp. nov. to *M. berdmorei* and status of *M. fowleri* requires further phylogenetic studies.

***Microhyla arboricola* sp. nov.** The phylogenetic position of *Microhyla arboricola* sp. nov. is unknown and requires further studies applying methods of molecular analyses. From preliminary data of external morphology it is also quite difficult to judge about taxonomic position of this species, among all other species of Indochinese *Microhyla* the new species shares some morphological features with *M. nanapollexa*, such as comparatively long hindlimbs, single metatarsal tubercle, decently developed digits on digits with median grooves dorsally, comparatively flattened toes with dermal fringes and miniature size, however phylogenetic value of these characters is unclear and a broad study of phylogenetic relationships within the genus *Microhyla* is needed to clarify evolutionary relationships of the new species.

Key to Identification of Adult Specimens of *Microhyla* Species Found in Vietnam

1 Digit tips dilated to wide disks bearing dorsal longitudinal median grooves producing an appearance of two scutes at least on toes 4
— Digit tips rounded, not dilated, if slightly widened, than no signs of dorsal longitudinal grooves discernible both on fingers and toes 2
2 Body habitus stout, hindlimbs very short (in adpressed limb tibiotarsal articulation barely reaching eye level), outer metatarsal tubercle large, shovel-like, maritime areas of southern Vietnam . . . . . *M. picta* Schenkel, 1901
— Body habitus stocky to slender, hindlimbs long (in adpressed limb tibiotarsal articulation to snout or beyond), outer metatarsal tubercle small, not shovel-like 3
3 Body size in adults large (SVL 23 – 37 mm), foot webbing well-developed reaching distal subarticular tubercle on third toe, hindlimbs long: tibiotarsal articulation reaches snout or just beyond, dorsum with numerous contrasting thin and wide parallel lines forming a Λ-shaped figure not connected to dark interorbital bar, groin with large bright yellow spots, throughout the country . . . . . *M. pulchra* (Hallowell, 1861)
— Body size in adults medium (SVL 18 – 28 mm), foot webbing basal, reaching proximal subarticular tubercles, hindlimbs shorter: tibiotarsal articulation shorter than snout, dorsum with few thick dark lines forming Λ-shaped figure with irregular borders connected to dark interorbital bar, groin without bright yellow spots, throughout the country . . . . . *M. fissipes* Boulenger, 1884
4 Foot webbing complete, interdigital web reaching beyond the level of distal subarticular tubercles and reaching disks at all toes at least as a fringe 5
— Foot webbing basal, interdigital web not reaching the level of penultimate subarticular tubercles and not continuing to toe disks as fringes 12
5 First finger rudimentary, present as a nub or as a pronounce bulge, mt. Ngoc Linh in central Vietnam . . . . . *M. nanapollexa* Bain et Nguyen, 2004
— First finger not reduced 6
6 Body size large, SVL 23.8 – 45.6, skin with small tubercles and pustules, disks on fingers absent or rudimentary, foot webbing very well developed and reaching disks at all toes or at all toes except toe IV 7
— Body size in adults less than 25.8, disks on fingers well developed, webbing less developed and not reaching toe disks at all toes 8

8 Body habitus slender, snout long, obtusely pointed in profile, fingers with rudimentary disks, disks on fingers weak, but dorsal median grooves discernible, foot webbing reaching disks at all toes except preaxial side of toe III and all sides of toe IV, dorsum bearing a dark chevron, irregular black spots on lateral sides of body, yellowish color at ventral sides of thighs and groin, throughout the country . . . . . *M. berdmorei* (Blyth, 1856)

— Body habitus stocky, triangular and notably flattened, snout short and rounded in profile, fingers lack disks and dorsal median grooves, foot webbing reaching disks at all fingers, dorsum with bronze-brown chevron contacting interorbital bar on head, no yellowish color on ventral surface of thighs and groin, Ngoc Linh Mt. . . . . M. *darevskii* sp. nov.

9 Dorsum skin highly granular and warty, body coloration brownish, with a small brown chevron on scapular area, Langbian Plateau . . . . . *M. annamensis* Smith, 1923

— Dorsum skin smooth or sometimes with occasional low tubercles, body coloration bearing a distinct dark mark with posterior projections. 10

10 Ventral coloration rich in contrast, with dark chin, belly heavily marbled with white and black spots, thigh marbled or deeply mottled, Annam (Truong Son) mountains of Central Vietnam . . . . . *M. marmorata* Bain et Nguyen, 2004

— Ventral coloration dusted brown or reddish-brown from throat to belly and thighs 11

11 Head comparatively narrow, median HL/HW rate 0.95, snout short, SVL up to 25.8 mm, legs with three to four dark cross-bands, webbing on toe IV reaches beyond the distal edge of medial subarticular tubercle, dorsum often with bright reddish color in males, Langbian Plateau . . . . . *M. pulchella* sp. nov.

— Head comparatively wide, HL/HW rate 0.98, snout long, SVL up to 20.2 mm, legs with one dark cross-band, webbing on toe IV reaches medial subarticular tubercle, dorsum brownish, no reddish color in males, Buon Luoi . . . . . *M. pulverata* Bain et Nguyen, 2004

12 First finger well-developed, longer than half of second finger length, small distinct reddish tubercles on dorsum sometimes arranged in longitudinal rows, dorsum with dark irregular marking edged with thin cream-white line, snout rounded, throughout the country . . . . . *M. butleri* Boulenger, 1900

— First finger reduced, shorter than half of second finger length, snout acuminate or rounded, no reddish tubercles in longitudinal rows, if dark dorsal marking with whitish edging present, snout acuminate 13

13 Frogs of diminutive size, SVL of adults 13.2 – 17.2, dorsum skin with distinctly granular, with distinct low tubercles and pustules, better developed in posterior parts of dorsum and on thighs 14

— Frogs of medium size, SVL of adults 16.5 – 26.5, dorsum skin smooth or feebly shagreened 15

14 Body habitus slender, snout rounded in profile, foot webbing rudimentary, present only between toes II and III reaching the level of proximal subarticular tubercles, two metatarsal tubercles, limbs short: at adpressed limb tibiotarsal articulation not reaching snout, characteristic yellow “)(”-shaped dorsal marking usually present in males, Dong Nai province . . . . . *M. minuta* sp. nov.

— Body habitus moderately slender, snout pointed in profile, foot webbing reaching the level of penultimate subarticular tubercles, single metatarsal tubercle, limbs long: at adpressed limb tibiotarsal articulation reaching well beyond snout, no yellow dorsal marking, Langbian Plateau . . . . . *M. arboricola* sp. nov.

15 Digital disk present only on finger III and poorly developed on toes, dorsum lacking a vertebral stripe, any dark markings including dark spot in the middle, dark dorsolateral bands, anterior surfaces of thighs and ventral surfaces of tarsus and foot are not black, hindlimbs short: tibiotarsal articulation in adpressed limb marks the hind edge of orbit, Langbian Plateau . . . . . *M. fusca* Andersson, 1942

— Digital disks present on three outer fingers and well developed on toes, dorsum with a light vertebral stripe and dark markings and a dark spot in the middle, dark dorsolateral bands present, front of thighs and lower surfaces of tarsus and foot with black markings, hindlimbs longer: in adpressed tibiotarsal articulation reaching the eye level or beyond 16

16 Hindlimbs comparatively longer (HLL/SVL 1.80 – 2.01), tibiotarsal articulation of adpressed limb reaching snout, usually protruding beyond margin of snout; hand with two low palmar tubercles and lacking any supernumerary tubercles, tongue deeply free at rear part for more than one-third of its length; dorsum brownish with dark dorsal spot and scapular ocelli and numerous smaller dark spots, pronounced interorbital bar, characteristic alternated light and dark brown stripes, forming pattern resembling grain of pine-wood; Langbian Plateau . . . . . *M. pineticola* sp. nov.

— Hindlimbs shorter (HLL/SVL 1.52 – 1.66), tibiotarsal articulation of adpressed limb usually not protruding beyond margin of snout; three distinct prominent palmar tubercles and supernumerary tubercles, tongue free about one-fourth of its length; dorsum nearly uniformly colored, usually beige with a thin mid-dorsal line, small central dorsal black spot and few dark spots; throughout the country . . . . . *M. heymonsi* Vogt, 1911

Acknowledgments. All fieldwork was conducted under the permission of the Department of Forestry, Ministry of Agriculture and Rural Development of Vietnam (permits No. 170/TCLN-BTTN; 831/TCLN-BTTN and 1430/GT-BNN-KL) and Chu Yang Sin National Park (agreement No. 493/KHNT-KH). The authors are grateful to Andrei N. Kuznetsov, Leonid P. Korzoun and Vitaly L. Trounov for support and organization of fieldwork. We sincerely thank our Vietnamese colleagues Nguyen Dang Hoi, Vu Manh, Tao Thien Nguyen, Ho Thu Cuc, Tran Tien, Le Xuan Son, Dinh Ba Duy, Nguyen Duc Anh for help and continued support. Many thanks to Alexei V. Abramov, Natalia B. Ananjeva, Dmitriy N. Fedo-

renko, Svetlana S. Gogoleva, Daniel A. Melnikov, Olga V. Morozova, Robert W. Murphy, Roman A. Nazarov, Igor V. Palko, Alexei A. Polilov, Evgeniy S. Popov, and Anton V. Schinov for their help and support during the fieldwork, assistance in the laboratory and continued support of this project. We are grateful to Director and Vice-Director of the Vietnam National Museum of Nature (VAST): Nguyen Dinh Cong and Nguyen Trung Minh and to the Chairman of Scientific board Pham Van Luc. We acknowledge the People's Committee of the Provinces of Lam Dong, Dak Lak and Khanh Hoa for permission to access to study sites, as well as to administration of Bidoup – Nui Ba National Park and personally the director of the National Park, Mr. Le Van Huong, and to administration of Chu Yang Sin National Park and personally the director of the National Park, Mr. Tong Ngoc Chung for continued support of our research. We thank rangers of Giang Ly and Hon Giao stations of the Bidoup – Nui Ba National Park for their hospitality and permanent support in the field: Ta Van Thuc, Nguyen Van Thien, Le Dang Dieu, Pham Huu Nhan and Dadu Ha Tien. We thank the Administration of Hon Ba Nature Reserve (Khanh Hoa Province) and Chu Yang Sin National Park (Dak Lak Province) for facilitating the research expedition, and rangers of the parks for their hospitality and assistance in the field. We are indebted to the team of Cat Tien National Park, Dong Nai Province for their hospitality and support. We are grateful to students of University of Science, Ho Chí Minh City: Ly Tri, Lien Quoc Dat, Nguyen Dinh Hien, Le Thi Thanh Ngan and Nguyen Anh Minh for support in the field and valuable discussions. For permission to study specimens under their care, we thank V. F. Orlova (ZMMU), Shin-ichiro Kawada (NSMT) and Wolfgang Böhme (ZFMK). We thank Wolfgang Böhme and Masayuki Sumida for providing literature, as well as for fruitfull discussions about the etymology of the new species, and Vladimir V. Shakhparonov for providing precious photos. Special thanks to Evgeniya N. Solovyeva, R. Wayne Van Devender, Paul Moler and You Chung-Wei for providing specimens and samples of rare *Microhyla* species, and to Parinya Pawangkhanant for continued support during fieldwork. We are grateful to Vitaly L. Trounov and Egil S. Scallagrimsson for help in preparation of illustrations. We are sincerely grateful to Robert W. Murphy and Natalia B. Ananjeva for their kind help and useful comments which helped us to improve the previous version of the manuscript. We are deeply obliged to Harold De Lisle and Jenny Hok for their patience and kind help with proofreading of the manuscript. Peter Geissler especially thanks Nguyen Quang Truong and Thomas Ziegler for their kind and valuable support during his work in Vietnam. The study was supported by a Grant of the President of Russian Federation (Grant Nos. MK-5815.2014.4; NS-2990.2014.4), the Russian Foundation of Basic Research (Grant Nos. RFBR Taiwan No. 14-04-92000; RFBR No. 13-04-00031a), the Alexander Koenig Society (Alexander Koenig Gesellschaft – AKG), the Alexander Koenig Foundation (Alexander Koenig Stiftung – AKS), IDEA WILD, and Nagao Natural Environment Foundation (NEF).

REFERENCES

AmphibiaWeb (2014), *Information on Amphibian Biology and Conservation* [web application], Berkeley, California: AmphibiaWeb. Available from http://amphibiaweb.org/ (accessed February – April 2014).

Andersson L. G. (1942), "A small collection of frogs from Annam collected in the years 1938 – 1939 by Bertil Björkegren," *Ark. Zool. Stockholm*, **34**(6), 1 – 11.

Bain R. H. and Hurley M. M. (2011), "A biogeographic synthesis of the amphibians and reptiles of Indochina," *Bull. Am. Mus. Nat. Hist.*, **360**, 1 – 138.

Bain R. H. and Nguyen T. Q. (2004), "Three new species of narrow-mouth frogs (genus *Microhyla*) from Indochina, with comments on *Microhyla annamensis* and *Microhyla palmipes*," *Copeia*, **2004**, 507 – 524.

Berry P. Y. (1975), *The Amphibian Fauna of Peninsular Malaysia*, Tropical Press, Kuala Lumpur.

Biju S. D., Van Bocxlaer I., Giri V. B., Roelants K., Nagaraju J., and Bossuyt F. (2007), "A new night frog, *Nyctibatrachus minimus* sp. nov. (Anura: Nyctibatrachidae): the smallest frog from India," *Curr. Sci.*, **93**, 854 – 858.

Blyth E. (1856 "1855"), "Report for October Meeting, 1855," *J. Asiatic Soc. Bengal*, **24**, 711 – 723.

Boulenger G. A. (1884), "Descriptions of new species of reptiles and batrachians in the British Museum. Part. II," *Ann. Mag. Nat. Hist. Ser. 5*, **13**, 396 – 398.

Boulenger G. A. (1890), "List of the reptiles, batrachians, and freshwater fishes collected by Professor Moesch and Mr. Iversen in the district of Deli, Sumatra," *Proc. Zool. Soc. London*, **1890**, 30 – 39.

Boulenger G. A. (1897), "Descriptions of new Malay frogs," *Ann. Mag. Nat. Hist. Ser. 6*, **19**, 106 – 108.

Boulenger G. A. (1900), "Descriptions of new batrachians and reptiles from the Larut Hills, Perak," *Ann. Mag. Nat. Hist. Ser. 7*, **6**, 186 – 193.

Boulenger G. A. (1909), "Descriptions of four new frogs and a new snake discovered by Mr. H. Sauter in Formosa," *Ann. Mag. Nat. Hist. Ser. 8*, **4**, 492 – 495.

Bourret R. (1942), *Les Batraciens de l'Indochine*, Institut Océanographique de l'Indochine, Hanoi.

Bowatte G. and Meegaskumbura M. (2011), "Morphology and ecology of tadpoles of *Ramanella obscura* (Anura: Microhylidae)," *Ceylon J. Sci. Biol. Sci.*, **40**, 109 – 120.

Carvalho A. L. de (1954), "A preliminary synopsis of the genera of American microhylid frogs," *Occas. Papers Mus. Zool. Univ. Michigan*, **555**, 1 – 19.

Che J., Chen H. M., Jin J. Q., et al. (2012), "Universal COI primers for DNA bar-coding amphibians," *Mol. Ecol. Resources*, **12**, 247 – 258.

Chou W.-H. and Lin J.-Y. (1997), "Tadpoles of Taiwan," *Spec. Publ. Natl. Mus. Taiwan*, **7**, 1 – 98.

Das I. and Haas A. (2010), "New species of *Microhyla* from Sarawak: Old World's smallest frogs crawl out of miniature pitcher plants on Borneo (Amphibia: Anura: Microhylidae)," *Zootaxa*, **2571**, 37 – 52.

Das I., Yaakob N. S., and Sukumaran J. (2007), "A new species of *Microhyla* (Anura: Microhylidae) from the Malay Peninsula," *Hamadryad*, **31**, 304 – 314.

De Koninck R. (1999), *Deforestation in Viet Nam*, International Research Centre, Ottawa.

Dubois A. (1987), "Miscelanea taxinomica batrachologica, II," *Alytes*, **6**, 1 – 9.

Duellman W. E. and Hedges S. B. (2008), "Two new minute species of *Phrynopus* (Lissamphibia: Anura) from the Cordillera Oriental in Peru," *Zootaxa*, **1675**, 59 – 66.

Duméril A. M. C. and Bibron G. (1841), *Erpétologie Générale ou Histoire Naturelle Complète des Reptiles. Vol. 8*, Librarie Encyclopedique de Roret, Paris.

Dutta S. K. and Manamendra-Arachchi K. (1996), *The Amphibian Fauna of Sri* Lanka, Wildlife Heritage Trust of Sri Lanka, Colombo.

Dutta S. K. and Ray P. (2000), "*Microhyla sholigari*, a new species of microhylid frog (Anura: Microhylidae) from Karnataka, India," *Hamadryad*, **25**, 38 – 44.

Estrada A. R. and Hedges S. B. (1996), "At the lower size limit in tetrapods: a new diminutive frog from Cuba (Leptodactylidae: *Eleutherodactylus*)," *Copeia*, **1996**, 852 – 859.

Fei L., Hu S.-q., Ye C.-y., and Huang Y.-z. (2009), *Fauna Sinica. Amphibia. Vol. 2, Anura*, Science Press, Beijing.

Fei L., Ye C.-y., Huang Y.-z., Jiang J.-p., and Xie F. (2005), *An Illustrated Key to Chinese Amphibians*, Sichuan Publishing House of Science and Technology, Chongqing.

Fernando P. and Siriwardhane M. (1996), "*Microhyla karunaratnei* (Anura: Microhylidae), a new species of frog endemic to Sri Lanka," *J. S. Asian Nat. Hist. Colombo*, **2**, 135 – 142.

Frost D. R. (2014), *Amphibian Species of the World: An Online Reference. Ver. 6.0*, American Museum of Natural History, New York. Available from http://research.amnh.org/herpetology/amphibia/index.php/ (accessed April 2014).

Geissler P., Nazarov R., Orlov N. L., Böhme W., Phung M. T., Nguyen Q. T., and Ziegler T. (2009), "A new species of the *Cyrtodactylus irregularis* complex (Squamata: Gekkonidae) from southern Vietnam," *Zootaxa*, **2161**, 20 – 32.

Gosner K. L. (1960), "A simplified table for staging anuran embryos and larvae," *Herpetologica*, **16**, 183 – 190.

Hallowell E. (1861) "1860," "Report upon the Reptilia of the North Pacific Exploring Expedition, under command of Capt. John Rogers, U. S. N.," *Proc. Acad. Nat. Sci. Philadelphia*, **12**, 480 – 510.

Hartmann T., Geissler P., Poyarkov N. A., Jr., Ihlow F., Galoyan E. A., Rödder D., and Böhme W. (2013), "A new species of the genus *Calotes* Cuvier, 1817 (Squamata: Agamidae) from southern Vietnam," *Zootaxa*, **3599**(3), 246 – 260.

Hasan M. K., Islam M. M., Kuramoto M., Kurabayashi A., and Sumida M. (2014), "Description of two new species of *Microhyla* (Anura: Microhylidae) from Bangladesh," *Zootaxa*, **3755**, 401 – 408.

Hu S.-q., Zhao E.-m., and Liu C.-c. (1966), "A herpetological survey of the Tsinling and Ta-Pa Shan region," *Acta Zool. Sinica*, **18**, 57 – 89 [in Chinese with English abstract].

Inger R. F. (1966), "The systematics and zoogeography of the Amphibia of Borneo," *Fieldiana. Zool.*, **52**, 1 – 402.

Inger R. F. (1989), "Four new species of frogs from Borneo," *Malayan Nat. J.*, **42**, 229 – 243.

Inger R. F. and Frogner K. J. (1979), "New species of narrow-mouth frogs (genus *Microhyla*) from Borneo," *Sarawak Mus. J.*, **27**, 311 – 322.

Inger R. F., Orlov N. L., and Darevsky I. S. (1999), "Frogs of Vietnam: a report on new collections," *Fieldiana. Zool. New Ser.*, **92**, iii – iv, 1 – 46.

Jerdon T. C. (1853), "Catalogue of reptiles inhabiting the Peninsula of India," *J. Asiatic Soc. Bengal*, **22**, 522 – 534.

Kuramoto M. and Joshy S. H. (2006), "Morphological and acoustic comparisons of *Microhyla ornata*, *M. fissipes*, and *M. okinavensis* (Anura: Microhylidae)," *Curr. Herpetol. Kyoto*, **25**, 15 – 27.

Kuznetsov A. N., Kuznetsova S. P., and Phan Luong (2006), "The forest vegetation on the mountain massives Bi Dup and Hon Ba, southern part of the main Himalayan ridge Chuong Son," in: Korzoun L. P., Rozhnov V. V., and Kalyakin M. V. (eds.), *Materials of Zoological and Botanical Studies in Bi Doup and Hon Ba mountains, Dalat Plateau, south of Vietnam. Series Biodiversity of Vietnam*, KMK, Moscow – Hanoi, pp. 9 – 115.

Laurance W. F. (2007), "Forest destruction in tropical Asia," *Curr. Sci.*, **93**(11), 1544 – 1550.

Malkmus R., Manthey U., Vogel G., Hoffmann P., and Kosuch J. (2002), *Amphibians & Reptiles of Mount Kinabalu* (*North Borneo*), A. R. G. Gantner Verlag, Ruggell.

Manthey U. and Grossmann W. (1997), *Amphibien & Reptilien Südostasiens*, Natur und Tier Verlag, Münster.

Matsui M. (1984), "Morphometric variation analyses and revision of the Japanese toads (genus *Bufo*, Bufonidae)," *Contrib. Biol. Lab. Kyoto Univ.*, **26**, 209 – 428.

Matsui M. (1994), "A taxonomic study of the *Rana narina* complex, with description of three new species (Amphibia: Ranidae)," *Zool. J. Linn. Soc.*, **111**, 385 – 415.

Matsui M. (2011), "Taxonomic revision of one of the Old World's smallest frogs, with description of a new Bornean *Microhyla* (Amphibia, Microhylidae)," *Zootaxa*, **2814**, 33 – 49.

Matsui M., Hamidy A., and Eto K. (2013), "Description of a new species of *Microhyla* from Bali, Indonesia (Amphibia, Anura)," *Zootaxa*, **3670**, 579 – 590.

Matsui M., Hamidy A., Belabut D. M., Ahmad N., Panha S., Sudin A., Khonsue W., Oh H.-S., Yong H.-S., Jiang J.-p., and Nishikawa K. (2011), "Systematic relationships of Oriental tiny frogs of the family Microhylidae (Amphibia, Anura) as revealed by mtDNA genealogy," *Mol. Phylogen. Evol.*, **61**, 167 – 176.

Matsui M., Ito H., Shimada T., Ota H., Saidapur S. K., Khonsue W., Tanaka-Ueno T., and Wu G.-F. (2005), "Taxonomic relationships within the Pan-Oriental narrow-mouth toad, *Microhyla ornata* as revealed by mtDNA analysis (Amphibia, Anura, Microhylidae)," *Zool. Sci.*, **22**, 489 – 495.

Meijer W. (1973), "Devastation and Regeneration of Lowland Dipterocarp Forests in Southeast Asia," *BioScience*, **23**(9), 528 – 533.

Meyfroidt P. and Lambin E. F. (2008), "Forest transition in Vietnam and its environmental impacts," *Global Change Biol.*, **14**(6), 1319 – 1336.

Murphy R. W., Crawford A. J., Bauer A. M., Che J., Donnellan S. C., Fritz U., Haddad C. F. B., Nagy Z. T., Poyarkov N. A., Vences M., Wang W.-zh., and Zhang Y.-p. (2013), "Cold Code: the global initiative to DNA barcode amphibians and nonavian reptiles," *Mol. Ecol. Resources*, **13**(2), 161 – 167.

Nazarov R. A., Orlov N. L., Nguyen N. S., and Ho T. C. (2008), "Taxonomy of naked-toes geckos *Cyrtodactylus irregularis* complex of South Vietnam and description of a new species from Chu Yang Sin Natural Park (Krong Bong district Dac Lac province, Vietnam)," *Russ. J. Herpetol.*, **15**, 141 – 156.

Nazarov R., Poyarkov N. A., Orlov N. L., Phung T. M., Nguyen T. T., Hoang D. M., and Ziegler T. (2012), "Two new cryptic species of the *Cyrtodactylus irregularis* complex (Squamata: Gekkonidae) from southern Vietnam," *Zootaxa*, **3302**, 1 – 24.

Ngo V. T. (2013), "*Cyrtodactylus* dati, a new forest dwelling Bent-toed Gecko (Squamata: Gekkonidae) from southern Vietnam," *Zootaxa*, **3616**(2), 151 – 164.

Ngo V. T. and Bauer A. M. (2008), "Descriptions of two new species of *Cyrtodactylus* Gray, 1827 (Squamata: Gekkonidae) endemic to southern Vietnam," *Zootaxa*, **1715**, 27 – 42.

Ngo V. T. and Chan K. O. (2010), "A new species of *Cyrtodactylus* Gray, 1826 (Squamata: Gekkonidae) from Khanh Hoa province, Southern Vietnam," *Zootaxa*, **2504**, 47 – 60.

Nguyen V. S., Ho T. C., and Nguyen Q. T. (2005), *A Checklist of the Amphibians and Reptiles of Vietnam*, Nha Xuat Ban Hong Nghiep, Hanoi [in Vietnamese].

Nguyen V. S., Ho T. C., and Nguyen Q. T. (2009), *Herpetofauna of Vietnam*, Edition Chimaira, Frankfurt am Main.

Ohler A., Swan S. R., and Daltry J. C. (2002), "A recent survey of the amphibian fauna of the Cardamom Mountains, southwest Cambodia with descriptions of three new species," *Raffles. Bull Zool.*, **50**, 465 – 481.

Orlov N. L. and Ananjeva N. B. (2007), *Amphibians of South-East Asia*, St. Petersburg Univ. Press, St. Petersburg.

Orlov N. L., Kharin V. E., Ananjeva N. B., Nguyen Th. T., and Nguyen Q. T. (2009), "A new genus and species of colubrid snake (Squamata, Ophidia, Colubridae) from South Vietnam (Lam Dong province)," *Russ. J. Herpetol.*, **16**(3), 228 – 240.

Orlov N. L., Murphy R. W., Ananjeva N. B., Ryabov S. A., and Ho T. C. (2002), "Herpetofauna of Vietnam, a checklist. Part 1. Amphibia," *Russ. J. Herpetol.*, **9**(2), 81 – 104.

Orlov N. L., Poyarkov N. A., Vassilieva A. B., Ananjeva N. B., Nguyen Thien Tao, Nguyen Van Sang, and Geissler P. (2012), "Taxonomic notes on rhacophorid frogs (Rhacophorinae: Rhacophoridae: Anura) of southern part of Annamite Mountains (Truong Son, Vietnam), with description of three new species," *Russ. J. Herpetol.*, **19**(1), 23 – 64.

Paiarkov [Poyarkov] N. A., Vassilieva A. B. (2011), "Chapter 5. Reptiles and Amphibians of Bidoup – Nui Ba National Park," in: Nguyen Dang Hoi and Kuznetsov A. N. (eds.), *Da Dang Sinh Hoc Va Dac Trung Sinh Thai Vuon Quoc Gia Bidoup – Nui Ba* [Biodiversity of the Bidoup – Nui Ba National Park], Nha Xuat Ban Hoa Hoc Tu Nhien Va Cong Nghe Publishing House, Hanoi, pp. 169 – 220 [in Vietnamese].

Parker H. W. (1928), "The brevicipitid frogs of the genus *Microhyla*," *Ann. Mag. Nat. Hist. Ser.* 10, **2**, 473 – 499.

Parker H. W. (1934), *A Monograph of the Frogs of the Family Microhylidae*, Trustees of the British Museum, London.

Parker H. W. and Osman-Hill W. C. (1949 "1948"), "Frogs of the genus *Microhyla* from Ceylon," *Ann. Mag. Nat. Hist. Ser. 12*, **1**, 759 – 764.

Pillai R. S. (1977), "On two frogs of the family Microhylidae from Andamans including a new species," *Proc. Indian Acad. Sci. Sect. B*, **86**, 135 – 138.

Pyron R. A. and Wiens J. J. (2011), "A large-scale phylogeny of Amphibia including over 2800 species, and a revised classification of advanced frogs, salamanders, and caecilians," *Mol. Phylogen. Evol.*, **61**, 543 – 583.

Rowley J. J. L., Le T. T. D., Hoang D. H., Dau Q. V., and Cao T. T. (2011a), "Two new species of *Theloderma* (Anura: Rhacophoridae) from Vietnam," *Zootaxa*, 3098, 1 – 20.

Rowley J. J. L., Le D. T. T., Tran D. T. A., and Hoang D. H. (2011b), "A new species of *Leptolalax* (Anura: Megophryidae) from southern Vietnam," *Zootaxa*, **2796**, 15 – 28.

Rowley J. J. L., Le T. T. D., Tran T. A. D., Stuart B. L., and Hoang D. H. (2010), "A new tree frog of the genus *Rhacophorus* (Anura: Rhacophoridae) from southern Vietnam," *Zootaxa*, **2727**, 45 – 55.

Rowley J. L., Dao T. T. A., Duong L. T. T., Huy H. D., and Altig R. (2012a), "The strangest tadpole: the oophagous, tree-hole dwelling tadpole of *Rhacophorus vampyrus* (Anura: Rhacophoridae) from Vietnam," *J. Nat. Hist.*, **46**, 2969 – 2978.

Rowley J. J. L., Tran D. T. A., Hoang H. D., and Le D. T. T. (2012b), "A new large species of large Flying Frog (Rhacophoridae: *Rhacophorus*) from lowland forests of southern Vietnam," *J. Herpetol.*, **46**, 480 – 487.

Savage J. M. (1975), "Systematics and distribution of the Mexican and Central American stream frogs related to *Eleutherodactylus rugulosus*," *Copeia*, **1975**, 254 – 306.

Schenkel E. (1901), "Achter Nachtrag zum Katalog der herpetologischen Sammlung des Basler Museums," *Verhandl. Naturforsch. Ges. Basel*, **13**, 142 – 199.

Semenov D. V. (2001), "Herpetological observations in the Vu Quang Nature Reserve, Ha Tinh Province, Vietnam (Vertebrata: Amphibia et Reptilia)," in: L. P. Korzun and M. V. Kalyakin (eds.), *Materials of Zoological and Botanical Studies in Vu Quang Nature Reserve* (*Ha Tinh Province*, *Vietnam*), Joint Russian-Vietnamese Science and Technology Tropical Centre, Moscow, pp. 332 – 346 [in Russian].

Smith A. M., Poyarkov N. A., and Hebert P. D. N. (2008), "CO1 DNA bar-coding amphibians: take the chance, meet the challenge," *Mol. Ecol. Notes*, **8**(2), 235 – 246.

Smith M. A. (1923), "Notes on reptiles and batrachians from Siam and Indo-China (No. 2)," *J. Nat. Hist. Soc. Siam*, **6**, 47 – 53.

Stejneger L. (1901), "Diagnoses of eight new batrachians and reptiles from the Riu Kiu Archipelago, Japan," *Proc. Biol. Soc. Wash.*, **14**, 189 – 191.

Stuart B. L. (1999), "Amphibians and reptiles," in: J. W. Duckworth, R. E. Salter, and K. Khounboline (eds.), *Wildlife in Lao PDR*: *1999 status report*, IUCN, Vientiane, pp. 43 – 68.

Stuart B. L., Rowley J. J. L., Tran D. T. A., Le D. T. T., and Hoang D. H. (2011), "The *Leptobrachium* (Anura: Megophryidae) of the Langbian Plateau, southern Vietnam, with description of a new species," *Zootaxa*, **2804**, 25 – 40.

Tarkhnishvili D. N. (1994), "Amphibian communities of the southern Viet Nam: Preliminary data," *J. Bengal Nat. Hist. Soc. New Ser.*, **13**, 3 – 62.

Tarkhnishvili D. N. (1995), "Utilization of aquatic breeding sites by amphibia of Ma Da Forest (South Vietnam)," *Russ. J. Ecol.*, **26**, 106 – 111 [Translated from *Ékologiya* (1995), **25**, 123 – 129, in Russian].

Taylor E. H. (1934), "Zoological results of the third De Schauensee Siamese Expedition, Part III," *Amphibians and Reptiles. Proc. Acad. Nat. Sci. Philadelphia*, **86**, 281 – 310.

Taylor E. H. (1962), "The amphibian fauna of Thailand," *Univ. Kansas Sci. Bull.*, **43**, 265 – 599.

Tschudi J. J. v. (1838), *Classification der Batrachier mit Berücksichtigung der fossilen Thiere dieser Abtheilung der Reptilien*, Petitpierre, Neuchâtel.

Vassilieva A. B., Galoyan E. A., Gogoleva S. I., and Poyarkov N. A., Jr. (2014), "Two new species of *Kalophrynus* Tschudi, 1838 (Anura: Microhylidae) from the Annamite mountains in southern Vietnam," *Zootaxa*, **3796**(3), 401 – 434.

Vassilieva A. B., Galoyan E. A., and Poyarkov N. A., Jr. (2013a), "*Rhacophorus vampyrus* (Anura: Rhacophoridae) reproductive biology: a new type of oophagous tadpole in Asian Treefrogs," *J. Herpetol.*, **47**(4), 607 – 614.

Vassilieva A. B., Geissler P., Galoyan E. A., Poyarkov N. A., Jr., Van Devender R. W., and Böhme W. (2013b), "A new species of kukri Snake (*Oligodon* Fitzinger, 1826; Squamata: Colubridae) from the Cat Tien National Park, southern Vietnam," *Zootaxa*, **3702**(3), 233 – 246.

Vogt T. (1911), "Beitrage zur Amphibien-fauna der Insel Formosa," *Sitzungsb. Ges. Naturforsch. Fr. Berlin*, **1911**, 179 – 184.

Yang D.-t. and Rao D.-q. (eds.) (2008), *Amphibia and Reptilia of Yunnan*, Yunnan Publishing Group Corporation – Yunnan Science and Technology Press, Kunming.

Ziegler T. (2002), *Die Amphibien und Reptilien eines Tieflandfeuchtwald-Schutzgebietes in Vietnam*, NTV Wissenschaft, Münster, Germany.

APPENDIX.
Material Examined for Morphological Comparisons
(museum ID-numbers are followed with brief locality information, field numbers if present, number of examined specimens and type status given in brackets)

M. achatina: ZMMU A-5054 (Indonesia, Java, N from Bandung, Juanda; NAP-04415; 2 sp.); ZMMU A-5070 (Indonesia, Java, Ujung Kulon; ABV-00410; 1 sp.).

M. annamensis: ZMMU A-5069 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01310, NAP-01317, NAP-01378 – 01379; 4 sp.); ZMMU A-5075 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01799, NAP-01801 – 01809, NAP-01811 – 01812, NAP-01827 – 01829, NAP-01882; 16 sp.); ZMMU A-4337 (Vietnam, Lam Dong, Bidoup – Nui Ba NP; NAP-00501, NAP-00521; 2 sp.); ZISP 11815 (Vietnam, Lam Dong, Bidoup Mt., B; 1 sp.); ZMMU A-5055 (Vietnam, Dak Lak, Chu Yang Sin; NAP-02612, NAP-02693, NAP-02710; 3 sp.); ZISP 11818 (Vietnam, Dak Lak, Chu Yang Sin; TAO-494; 1 sp.); ZMMU A-5056 (Vietnam, Khanh Hoa, Hon Ba Mt.; 1 sp.); ZMMU A-4899 (Vietnam, Dak Lak, Chu Yang Sin; NAP-02643 – 02644, NAP-02699, NAP-02703, NAP-02709; 5 sp.); ZISP 11821 – 11825 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., Giang Ly; 5 sp.); ZMMU A-5069 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01310; NAP-01317; NAP-01378 – 01379; 4 sp.); ZMMU A-5075 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P.; NAP-01882; NAP-01811; NAP-01812; NAP-01029; NAP-01827; NAP-01828; NAP-01799; NAP-01801 – 01809; 9 sp.); ZFMK 95612 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P.; DT0013); ZFMK 95613 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P.; DT0014); ZFMK 95614 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P.; DT0153); ZFMK 95615 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P.; DT0160).

M. arboricola sp. nov.: ZMMU A-5051 (Vietnam, Dak Lak, Chu Yang Sin; NAP-02700; 1 sp.; holotype); ZMMU A-5052 (Vietnam, Khanh Hoa, Hon Ba; ABV-00265 – 00268, ABV-00270; 5 sp.; paratypes); ZMMU A-4845 (Vietnam, Dak Lak, Chu Yang Sin; ABV-00060 – 00062, ABV-00084, ABV-00085; 5 sp.; paratypes); ZISP 11813 – 11814 (Vietnam, Dak Lak, Chu Yang Sin; TAO-581; TAO-654; 2 sp.; paratypes).

M. berdmorei: ZMMU A-4731 (Vietnam, Dong Nai, Vinh Cuu, Ma Da; NAP-01532, NAP-01546 – 01547; 3 sp.); ZMMU A-4643 (Vietnam, Dak Lak, Yok Don Mt.; NAP-02595, NAP-02596; 2 sp.); ZMMU A-4330 (Vietnam, Lam Dong, Bidoup – Nui Ba NP; NAP-00420 – 00421, NAP-00423, NAP-00425 – 00429, NAP-00431 – 00440, NAP-00452 – 00457; NAP-00506; NAP-00511; NAP-00515; NAP-00524; NAP-00422; NAP-00424; NAP-00430; NAP-00430; 30 sp.); ZMMU A-5073 (same locality; NAP-01314; NAP-01314; NAP-01721; NAP-02973; 4 sp.); ZMMU A-5058 (Laos, Khammouane; 237 – 239; 3 sp.).

M. butleri: ZMMU A-4742 (Vietnam, Dong Nai, Nam Cat Tien; NAP-01586; NAP-01678 – 01679, NAP-01696; 4 sp.); ZMMU A-4685 (Vietnam, Dak Lak, Yok Don Mt.; NAP-02390 – 02392; 3 sp.); ZMMU A-4824 (Vietnam, Khanh Hoa, Cam Ranh; NAP-03204; NAP-03214 – 03216; 4 sp.); ZMMU A-4922 (Vietnam, Ba Ria – Vung Tau, Binh Chau – Phuoc Buu; NAP-03863 – 03865; 3 sp.); ZMMU A-5071 (Vietnam,

Quang Tri, Phong Nha — Ke Bang NP, Hoang Lap; 31288; 1 sp.).

M. darevskii sp. nov.: ZISP 7370 (Vietnam, Kon Tum, Ngoc Linh, Mang Xang; 21396; 1 sp.; holotype); ZISP 7311, ZISP 7312 (same locality; 21394- 21395; 2 sp.; paratypes); ZMMU A-5050 (same locality; 21397, 21398; 2 sp.; paratypes).

M. fissipes: ZMMU A-4618 (Vietnam, Dong Nai, Nam Cat Tien; NAP-00007; 1 sp.); ZMMU A-4633 (Vietnam, Ba Ria – Vung Tau, Con Dao, Con Son; NAP-00030; 1 sp.); ZMMU A-4755 (Vietnam, Dong Nai, Vinh Cuu, Ma Da; NAP-00710; 2 sp.); ZMMU A-4973 (China, Taiwan, Yong Chin, Qi Kong; NAP-01043 – 01045; 3 sp.); ZMMU A-4652 (Vietnam, Lam Dong, Cat Tien, Cat Loc; NAP-01617; 1 sp.); ZMMU A-4686 (Vietnam, Dak Lak, Yok Don Mt.; NAP-02312 – 02315, NAP-02333; 5 sp.); ZMMU A-4832 (Vietnam, Ba Ria – Vung Tau, Binh Chau – Phuoc Buu; NAP-03027 – 03028, NAP-03079 – 03084; 8 sp.); ZMMU A-5064 (Laos, Khammouane; 159, 234 – 236, NAP-04182; 5 sp.); ZMMU A-5065 (Vietnam, Dak Lak, Chu Yang Sin; 36551; 1 sp.); NSMT-1665 – 1675 (China, Taiwan, Chia-i Hsien, Shih-tzu-lu [Jujiro]; 11 sp.).

M. heymonsi: ZMMU A-4631 (Vietnam, Ba Ria – Vung Tau, Con Dao, Con Son; NAP-00027; NAP-00028; 2 sp.); ZMMU A-4672 (Vietnam, Dong Nai, Nam Cat Tien; NAP-00083; 1 sp.); ZMMU A-4975 (China, Taiwan, Yong Chin, Qi Kong; NAP-01042; 1 sp.); ZMMU A-4722 (Vietnam, Dong Nai, Vinh Cuu, Ma Da; NAP-01534 – 01535, NAP-01545, NAP-01566; 4 sp.); ZMMU A-4683 (Vietnam, Dak Lak, Yok Don Mt.; NAP-02316; 1 sp.); ZMMU A-4658 (Vietnam, Ba Ria – Vung Tau, Binh Chau – Phuoc Buu; NAP-03029 – 03033, NAP-03037, NAP-03086 – 03090; 11 sp.); ZMMU A-5059 (Vietnam, Quang Nam; NAP-04198; 2 sp.); ZMMU A-5060 (Laos, Khammouane; 101; 3 sp.).

M. mantheyi: collection of Dep. of Vertebrate Zoology, Biol. faculty, Lomonosov Moscow State Univ. (Thailand, Narathiwat, Hala-Bala NP; no number; 1 sp.).

M. marmorata: ZMMU A-5074 (Vietnam, Quang Nam, Na Hang; NAP-04195 – 04197; 3 sp.); ZMMU A-5072 (Vietnam, Quang Tri, Phong Nha — Ke Bang NP, Hoang Lap; 31281; 1 sp.); ZMMU A-5061 (Vietnam, Kon Tum, Kon Plong, Mang Canh; 39419, 39465; 2 sp.).

M. minuta sp. nov.: ZMMU A-5047 (Vietnam, Dong Nai, Nam Cat Tien; NAP-02072; 1 sp.; holotype); ZMMU A-5048 (same locality; NAP-02073, NAP-02074; NAP-02091 – 02098; 10 sp., paratypes); ZISP 11812 (same locality; NAP-02090; 1 sp.; paratype); ZFMK 96230 (Vietnam, Dong Nai, Nam Cat Tien; field number 10343 paratype); IEBR A.2013.113 (Vietnam, Dong Nai, Nam Cat Tien; field number 10309; paratype).

M. mixtura: CIB-610174 (China, Sichuan, Huae-Shan; 1 sp.; holotype).

M. okinavensis: NSMT-1656 – 1664 (Japan, Kagoshima, Yoron-to, Chabana; 9 sp.); NSMT-1649 – 1651 (Japan, Okinawa, Iriomote-jima, Hashitate/Shirahama; 3 sp.).

M. ornata: ZMMU A-4948 (Nepal, Parsa; EAG-0008; 1 sp.).

M. palmipes: ZMMU A-5067 (Indonesia, Java, Yogjakarta; NAP-04414; 3 sp.).

M. picta: ZMMU A-4823 (Vietnam, Khanh Hoa, Cam Ranh; NAP-03212; NAP-03213; 2 sp.); ZMMU A-4918 (Vietnam, Ba Ria – Vung Tau, Binh Chau – Phuoc Buu; NAP-03843 – 03846; NAP-03861; NAP-03862; 6 sp.); ZMMU A-4523 (Vietnam, Ba Ria-Vung Tau, Con Dao, Con Son; NAP-00584 – 00586; NAP-00588; NAP-00564; 5 sp.).

M. pineticola sp. nov.: ZMMU A-5043 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Bidoup Mt.; NAP-01032; 1 sp.; holotype); ZMMU A-5080 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01750, NAP-01800, NAP-01883 – 01885; 5 sp.; paratypes); ZMMU A-4812 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Gaing Ly; NAP-01033, NAP-01150 – 01153; NAP-01158 – 01160, 2 sp. no labels; 9 sp., paratypes); ZMMU A-4813 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Bidoup Mt.; NAP-01033; 1 sp., paratype); ZMMU A-4333 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Long Lanh; NAP-00106, NAP-00522; 2 sp., paratypes); ZMMU A-4331 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Da Nhim; NAP-00552 – 00553, NAP-01316, NAP-01422; 4 sp.; paratypes); ZMMU A-5043 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Bidoup Mt.; NAP-01170; 1 sp.; paratype); ZISP 11816 (Vietnam, Lam Dong, Bidoup Mt., A; 1 sp., paratype); ZISP 11819 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., Giang Ly; 1 sp., paratype); ZFMK 95625 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., DT0190, paratype); ZFMK 95626 – 95627 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., 3 sp., paratypes); UNS 5093 – 5097 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., 5 sp., paratypes); UNS 5098 – 5101 (Vietnam, Dak Lak, Chu Yang Sin N. P., 4 sp., paratypes); ZFMK 95628, 95629 (Vietnam, Dak Lak, Chu Yang Sin N. P., 2 sp., paratypes).

M. pulchella sp. nov.: ZMMU A-5045 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01814; 1 sp.; holotype); ZMMU A-5068 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01815 – 01818, NAP-01820, NAP-01823, NAP-01824; 7 sp.; paratypes); ZMMU A-5078 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Giang Ly; NAP-01374 – 01376, NAP-01406; 4 sp.; paratypes); ZMMU A-5079 (Vietnam, Lam Dong, Bidoup – Nui Ba NP, Hon Giao Mt.; 8 sp.; paratypes); ZISP 11817 (Vietnam, Lam Dong, Bidoup Mt.; C; 1 sp., paratype); ZISP 11820 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., Giang Ly; 1 sp., paratype); ZMMU A-5053 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., Bidoup Mt.; ABV-00488 – 00492, ABV-00506; 6 sp.); UNS 5102 – 5110 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., 9 sp., paratypes); ZFMK 95616 – 95624 (Vietnam, Lam Dong, Bidoup – Nui Ba N. P., 9 sp., paratypes).

M. pulchra: ZMMU A-4628 (Vietnam, Dong Nai, Nam Cat Tien; NAP-00014; 1 sp.); ZMMU A-4720 (Vietnam, Dong Nai, Vinh Cuu, Ma Da; NAP-01564; 1 sp.); ZMMU A-4682 (Vietnam, Dak Lak, Yok Don Mt.; NAP-02310, NAP-02311, NAP-02334, NAP-02335; 4 sp.); ZMMU A-4836 (Vietnam, Ba Ria – Vung Tau, Binh Chau – Phuoc Buu; NAP-03097, NAP-03098; 2 sp.); ZMMU A-5066 (Vietnam, Tuyen Quang, Na Hang; 1 sp.); ZMMU A-5062 (Laos, Khammouane; 97, 154, 156; 3 sp.).

M. pulverata: ZISP 6424 (Vietnam, Gia Lai, Buon Luoi; 4 sp.); ZMMU A-5063 (Vietnam, Kon Tum, Kon Plong, Mang Canh; 39290; 1 sp.).